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IAS STUDY GROUP

# Memory

## PAPER- 1 UNIT-7

Encoding and remembering; Short term memory, Long term memory, Sensory memory, Iconic memory, Echoic memory: The Multistore model, levels of processing; Organization and Mnemonic techniques to improve memory; Theories of forgetting: decay, interference and retrieval failure; Metamemory; Amnesia: Anterograde and retrograde.

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# A. Nature of Memory

## A.1 What is Memory?

Memory refers to retaining and recalling information over a period of time, depending on the type of task you are required to perform. Memory involves maintaining information over time. You can maintain this information for less than a second or as long as a lifetime. For example, you use memory to store the beginning of a word until you hear the end of the word. You also use memory to recall your own name, which you probably learned when you were about a year old.

Memory is so central to cognitive processes that it influences almost every aspect of every topic. Pattern recognition and attention are clearly affected by our memory for shapes and attentional strategies. Memory for words, general knowledge, and concepts; memory as an important part of both language understanding and language production clearly show that memory influences many other cognitive activities.

Memory is conceptualized as a process consisting of three independent, but interrelated stages – Encoding, Storage and Retrieval

### A.1.1 Encoding

Encoding is the first stage which refers to a process by which information is recorded and registered for the first time so that it becomes usable by our memory system.

Whenever an external stimulus impinges on our sensory organs, it generates neural impulses. These are received in different areas of our brain for further processing. In encoding, incoming information is received and some meaning is derived. It is then represented in a way so that it can be processed further.

### A.1.2 Storage

Storage is the second stage of memory. Information which was encoded must also be stored so that it can be put to use later. Storage, therefore, refers to the process through which information is retained and held over a period of time.

### A.1.3 Retrieval

Retrieval is the third stage of memory. Information can be used only when one is able to recover it from her/his memory. Retrieval refers to bringing the stored information to her/his awareness so that it can be used for performing various cognitive tasks such as problem solving or decision-making.

It may be interesting to note that memory failure can occur at any of these stages. You may fail to recall certain information because you did not encode it properly, or the storage was weak so you could not access or retrieve it when required.

# B. Theoretical Models of Memory

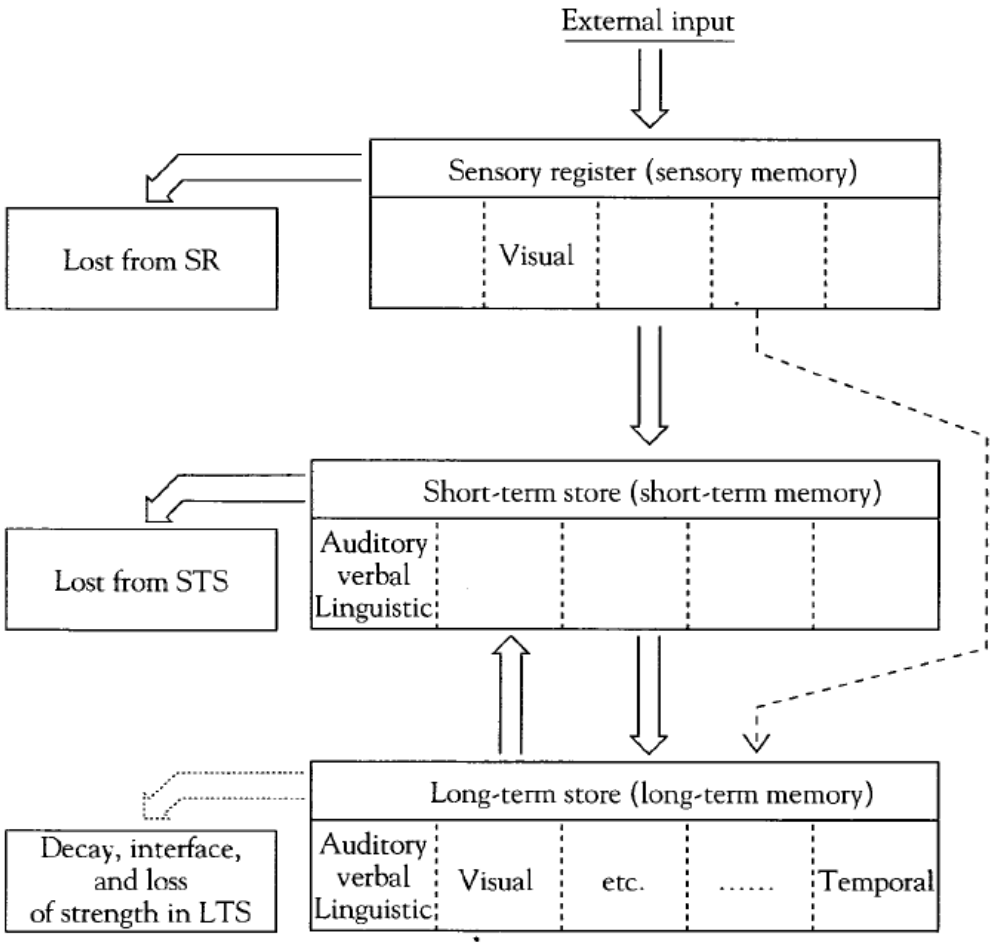
## B.1 Information Processing Model – Atkinson and Shiffrin

Initially, it was thought that memory is the capacity to store all information that we acquire through learning and experience. It was seen as a vast storehouse where all information that we knew was kept so that we could retrieve and use it as and when needed. But with the advent of the computer, human memory came to be seen as a system that processes information in the same way as a computer does. Both register, store, and manipulate large amount of information and act on the basis of the outcome of

such manipulations. Based on this analogy Atkinson and Shiffrin developed a model of memory known as **Multi-Stage Model** (also referred to as **Modal Model**).

According to the Stage Model, there are three memory systems: the **Sensory Memory**, the **Short-term Memory** and the **Long-term Memory**. Each of these systems has different features and performs different functions with respect to the sensory inputs. Figure below shows this model, with arrows to indicate that information is transferred from one storage area to another.

**Atkinson and Shiffrin's Model of Memory (Based on Atkinson & Shiffrin, 1968).**




Stimuli from the environment first enter sensory memory. Sensory memory is a large-capacity storage system that records information from each of the senses with -reasonable accuracy. Although touch, smell, and taste can be represented in sensory memory, cognitive psychologists are especially likely to study **iconic memory** (visual sensory memory) and **echoic memory** (auditory sensory memory). In any case, information in sensory memory decays rapidly. We will later examine the research on sensory memory in much more detail.

Atkinson and Shiffrin's model proposes that material from sensory memory then passes on to short-term memory. Short-term memory (abbreviated STM) contains only the small amount of information that we are actively using. Atkinson and Shiffrin proposed that verbal information in STM is encoded acoustically, in terms of its sounds. Memories in STM are fragile-though not as fragile as those in sensory memory-and they can be lost from memory within about 30 seconds unless they are somehow repeated. Short-term memory is discussed in much more detail later.

According to the model, material finally passes from short-term memory to long-term memory. Long-term memory (abbreviated LTM) has a large capacity and contains memories that are decades old, in addition to memories that arrived several minutes ago. Atkinson and Shiffrin proposed that information in L TM is encoded **semantically**, in terms of its meaning. Memories in LTM are relatively permanent, and they are not likely to be lost.

In terms of Atkinson and Shiffrin's model, the words in a sentence would first be registered in the auditory store of your sensory memory. That information could then be lost, or it could be transferred. In most cases involving transfer, the information would pass on to short-term memory, but that information could, as the dotted line in the figure suggests, possibly be transferred from sensory memory to long-term memory. Suppose, however, that the sentence does arrive in short-term memory. One option is that this information may be lost from short-term memory. The other option is that it can pass on to long-term memory. If that information reaches long-term memory, it may be lost; however, the dotted line next to long-term memory suggests that loss from long-term memory is less likely than in the other two kinds of memory. Information in long-term memory can also pass back into short-term memory when we want to actively work with that information again.

Atkinson and Shiffrin also proposed **control processes**, which are strategies that people use flexibly and voluntarily, depending upon the nature of the material and their own personal preferences. **Rehearsal** or silent repetition is one such kind of a control process. It encourages retaining and recycling information in short term memory. According to the model, information that is rehearsed frequently and kept for a long time in short-term memory is more likely to be transferred to long-term memory.

Control processes can operate in other ways in memory. For instance, people can decide whether they want to fill their short-term memory with material that needs to be remembered or to leave "work space" to think about something else. Furthermore, they can decide whether to use a particular memory strategy—such as a mental picture--to encode a sentence.

### B.1.1 Research on Atkinson and Shiffrin Model

There are some controversies regarding the following features of Multi-store model:

1. Concept of sensory memory – some evidence suggests the possibility of at least 2 kinds of iconic memory and 2 kinds of echoic memory. Further, some theorists have questioned whether concept of iconic memory is even worth retaining.
2. Another dispute in Atkinson and Shiffrin model is the distinction between short-term and Long-term memory. The consensus is that some research suggests that short term memory is really different from long term memory. However, other studies are compatible with the view that humans really have only one kind of memory.

Research that support Atkinson and Shiffrin model are as follows:

1. **Kintsch and Buschke's Research**: In one influential study, Kintsch and Buschke (1969) asked people to learn 16 English words in order. They proposed that the words from the beginning of the list would be in LTM when recall was requested because so much time had passed since they were presented. On the other hand, the most recent items should still be in STM. Their study focused upon one distinction that duplex theorists had proposed: material in STM is coded in terms of its acoustic or sound characteristics, whereas material in L TM is coded In terms of its semantic or meaning characteristics. The first study examined whether items at the beginning of the list-which were presumably in LTM would be influenced by semantic factors.

The second study examined whether items at the end of the list-which were presumably in STM-would be influenced by acoustic factors. First list contained pairs of synonyms, which are words that are similar to each other in meaning (i.e. sematically similar list). After the material had been presented, the experimenters supplied one word from the list. The participants were requested to supply the next word in the list. Kintsch and Buschke measured the number of instances of semantic confusion that occurred for items in each part of the list. They found that Items at the beginning of the list produced a greater number of semantic confusions than items at the end of the list. This result suggests that items at the beginning of the list, which should be in LTM, are coded in terms of their meaning.

The second list contains pairs of homonyms, which are words that are similar to each other in sound (i.e. acoustically similar list). Kintsch and Buschke found that acoustic confusions were more likely at the end of the list than at the beginning of the list. This result suggests that items at -the end of the list, which should be in STM, are coded in terms of their sound.

2. **Case of H.M. :** The neuroscience approach to memory has provided additional evidence for the Atkinson-Shiffrin model, especially through case studies of people with lesions. In an attempt to cure H.M.'s serious epilepsy, neurosurgeons removed portions of his temporal lobes and his hippocampus. The operation successfully cured the epilepsy, but it left him with a severe kind of memory loss. H.M. can accurately recall events that occurred before his surgery and his short-term memory is also normal. However, he cannot learn or retain any new information.

   Furthermore, he cannot recall more than 6 numbers in order, suggesting that his short-term memory is normal but he lacks the ability to transfer material from short-term memory to long-term memory.

Evidences against this model are as below:

1. Experimental evidence also contradicts other features of the Atkinson-Shiffrin model For example; the model proposes that information rehearsed for a long time in short-term memory is more likely to be transferred to long-term memory. However, earlier research by Tulving (1966) showed that in some situations the information people rehearsed frequently was not recalled any more accurately than unrehearsed information.
2. One crisp distinction used to be that short-term memory was acoustically coded, whereas long-term memory was semantically coded. However, more recent research has demonstrated that items in short-term memory can also be coded-in terms of their meaning.

   In addition, theorists pointed out that we often have a clear representation of the sound of an item in long-term memory; for example, the sound of a song may be encoded more clearly than its meaning. Thus, STM seems to be primarily acoustic, and LTM seems to be primarily semantic, but the distinction is fuzzy.
3. **Case of K.F.:** K.F. had been in a motorcycle accident, which damaged a portion of the left-side of his cerebral cortex. His long-term retention is normal, but his short-term memory is severely limited. The fact that H.M. has normal STM and abnormal LTM, whereas K.F. has abnormal STM and normal LTM, is often cited as strong evidence for the distinction between the two kinds of memory (e.g., Baddeley, 1990). However, the case of K.F. suggests a problem (Baddeley, 1990). The Atkinson-Shiffrin model proposes that information must pass through short-term memory before long-term learning can occur. If K.F. has abnormal short-term memory, how could his long-term memory be normal? It seems unlikely that all the material in his long-term memory came via the alternate route indicated in Figure, that is, directly from sensory memory.

## B.2 Levels-of-Processing Approach

The levels-of-processing view was proposed by Craik and Lockhart. This view suggests that the processing of any new information relates to the manner in which it is perceived, analysed, and understood which in turn determines the extent to which it will eventually be retained.

The levels-of-processing approach proposes that deep, meaningful kinds of information-processing lead to more permanent retention than shallow, sensory kinds of processing. Because of its emphasis on whether the processing is deep or shallow, the theory is also called the **depth-of-processing approach**. In general, then, the more meaning a person extracts from a stimulus, the greater the depth of processing.

Craik and Lockhart ( 1972) proposed that people can analyze stimuli at a number of different levels. The shallow levels involve analysis in terms of physical or sensory characteristics, such as brightness or pitch. At an intermediate level one might consider and attend to the phonetic sounds that are attached to the letters and therefore the structural features are transformed into at least one meaningful word. The deep levels involve analysis in terms of meaning. When you analyze for meaning, you may think of other, related associations, images, and past experiences related to the stimulus.

The by-product of all this analysis is **Memory trace**. If the stimulus is analysed at a very shallow level or at intermediate level (perhaps in terms of whether it had capital letters or whether it was printed in red), then that memory trace will be fragile (weak) and may be quickly forgotten. However, if the stimulus is analyzed at a very deep level (perhaps in terms of its semantic appropriateness in a sentence or in terms of the meaning category to which it belongs), then that memory trace will be durable: It will be remembered.

To sum up, analysing information in terms of its structural and phonetic features amounts to shallower processing while encoding it in terms of the meaning it carries (the semantic encoding) is the deepest processing level that leads to memory that resists forgetting considerably.

Craik and Lockhart also discussed rehearsal, the process of cycling information through memory, which we discussed in connection with the Atkinson-Shiffrin model. Craik and Lockhart proposed two kinds of rehearsal. **Maintenance rehearsal** merely repeats the kind of analysis that has already been carried out. In contrast, **elaborative rehearsal** involves a deeper, more meaningful analysis of the stimulus. Thus, if you see the word '*book'*, you could use maintenance rehearsal and simply repeat the sound of that word to yourself. On the other hand, you could use elaborative rehearsal by thinking of an image of a book or by relating the word *book* to another word on the list.

What will happen if you spend more time rehearsing? Craik and Lockhart predicted that, if you are using shallow maintenance rehearsal, then increasing rehearsal time will not influence later recall. Simply repeating the word book five more times will not make it any more memorable. However, if you are using deep elaborative rehearsal, then an increase in rehearsal time will be helpful. You can dig out all kinds of extra images, associations, and memories to enrich the stimulus, and later recall will be more accurate.

Craik and Lockhart's original description of levels-of-processing theory emphasized encoding, or how items are placed into memory. It did not mention details about retrieval, or how items are recovered from memory. In a later paper, Craik and another colleague proposed that retrieval conditions should duplicate encoding conditions in order for deep processing to be highly effective.

### B.2.1 Research on Levels of Processing Model

The major hypothesis emerging from Craik and Lockhart's (1972) paper was that deeper levels of processing should produce better recall. This hypothesis has been widely tested. Craik and Tulving ( 1975) found that people were about three times as likely to recall a word if they had originally answered questions about its meaning than if they had originally answered questions about the word's physical appearance.

Similarly, Parkin discovered that people who made semantic judgments about a word's category or its synonym performed much better on a surprise recall test than did people who made non-semantic judgments (for example, about the number of vowels contained in a word or whether it had been printed only in capital letters).

Reviews of dozens of studies conclude that deep processing generally produces higher recall scores than shallow processing.

Much of the research on this topic has focused on face recognition, the compatibility between encoding and retrieval, and the explanations for the effectiveness of deep processing.

Research has shown that shallow processing of faces-like shallow processing of words-leads to poor recall. For instance, research participants recognize a greater number of photos of faces if they make judgments about whether a person is honest, rather than the gender of the person or the width of the person's nose (Sporer).

Bloom and Mudd have provided an appealing explanation. Their research demonstrated that people who had been instructed to judge whether a person was honest looked at the faces longer and made more eye movements compared to people who had been instructed to judge whether a person was male or female. They argue that deeper processing leads to encoding a greater number of features and therefore superior recall. Alternately, when people make character judgments, they may encode the faces holistically, rather than in terms of isolated features.

Bransford and his colleagues (1979) found that people performed better on the rhyming test if they had originally performed the rhyming encoding task, rather than the sentence encoding task. Thus, the presumably "shallow" acoustic- task produced greater recall than the presumably "deep" semantic test. This research demonstrates that deep semantic processing may not be ideal unless the retrieval conditions are similar to the encoding conditions.

### B.2.2 Why is deep processing effective?

Craik and Lockhart (1986) believe that deep levels of processing encourage recall because of two factors: **distinctiveness** and **elaboration**.

Distinctiveness means that a stimulus is different from all other memory traces. Researchers have supported the value of distinctiveness. For instance, people recall words with distinctive sequences of short and tall letters, such as lymph, khaki, and afghan, better than words with common orthographic sequences, such as leaky, kennel, and airway (Hunt & Elliot).

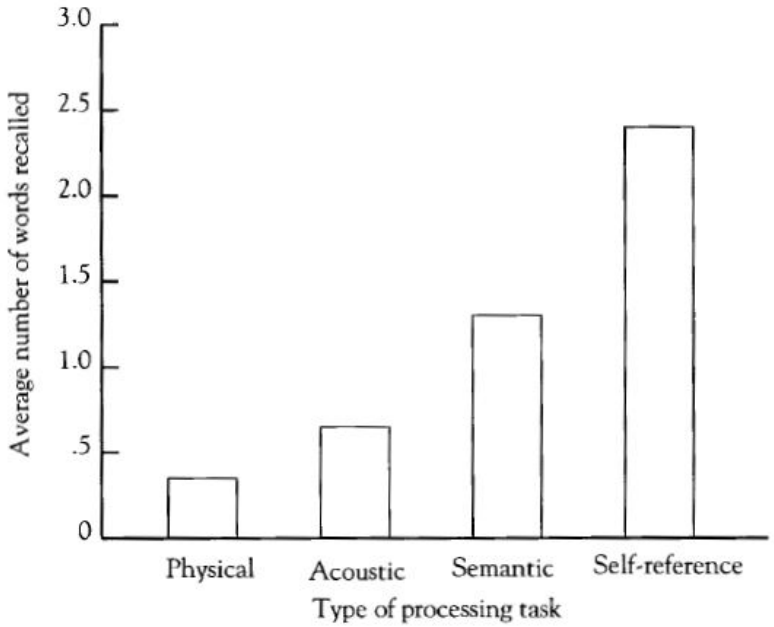
Elaboration involves rich processing in terms of meaning. More extensive elaboration leads to enhanced memory of stimuli. For example, elaborating a concepts or core ideas with multiple examples while learning will facilitate greater retention and recall.

### B.2.3 The Self-Reference Effect

The self-reference effect points out that people recall more information when they try to relate that information to themselves.

In the classic demonstration of the self-reference effect, Rogers, Kuiper, and Kirker (1977) asked participants to process lists of words according to the kinds of instructions usually studied in levels-of-processing research, that is, in terms of their physical characteristics, their acoustic (sound) characteristics, or their semantic (meaning) characteristics. However, other words were to be processed in terms of self-reference: People were asked to decide whether a particular word could be applied to themselves.

**Number of Words Recalled, as a Function of Level of Processing (Based on Rogers et al., 1977).**




As Figure illustrates, the self-reference task produced the best recall. Apparently, when we think about a word in connection with ourselves, we develop a particularly memorable coding for that word.

Why should we recall information especially well when we apply it to ourselves? Belezza suggests that the self is treated as a rich and organized set of internal cues to which information can be associated. Klein and Kihlstrom suggest that self-reference leads to better organization and hence recall is better.

### B.2.4 Current Status of Levels-of-Processing Model

One major contribution of the levels-of-processing approach is that it emphasized the importance of the mental processes that occur when the material is being learned. Another contribution is practical; we need to emphasize deep, meaningful processing if we want to improve retention.

However, the levels-of-processing approach also has drawbacks. The first problem **Circularity**: We have no independent assessment of depth (Nelson). Specifically, we say that if processing is deep, then retention will be better. Then we say that because the retention was better, the processing must have been deep. To avoid circularity, researchers need a measure of depth-of-processing in advance that can predict which conditions will produce the best retention.

A second problem is Deep processing is not always better, because performance depends upon the way memory is tested. As discussed, shallow processing-in terms of sound-is more effective than deep processing when memory is tested by asking whether any words on a list rhyme with *toy*.

Though the model has contributed much to the understanding of memory, these two problems of the approach have prevented psychologists from developing this theory completely.

# C. Sensory Memory

Sensory memory holds information in a relatively raw, unprocessed form for a short time after the physical stimulus is no longer available. Thus, sensory memory permits some trace of a stimulus to remain after the stimulus itself has disappeared. Often this system is referred to as sensory storage or sensory registers because information from all the senses are registered here as exact replica of the stimulus.

Sensory memory holds an enormous amount of information. When you took up the phone number in the book, the number 458-8604 gets stored along with many other names and numbers on the pages. Although this memory system can store an enormous amount of information, it is not very useful in remembering the phone number, since the memory lasts less than 1 second.

According to the Atkinson and Shiffrin model, material from sensory memory next passes to short-term memory, which contains only the small amount of material we are actively using.

Researchers have conducted only a few studies on sensory memory in the "minor" senses, such as touch, smell, and taste (e.g., Hill & Bliss). The vast majority of information concerns vision and hearing. Therefore, we will look only at visual sensory memory (iconic memory) and auditory sensory memory (echoic memory).

## C.1 Why do we need sensory memory?

Psychologists propose that sensory memory is necessary for two major reasons. First, the stimuli that bombard your senses are constantly and rapidly changing. For example, consider what happens when you read the sentence "Why do we need sensory memory?" aloud to a friend. The *wh* sound from the *why* is long gone by the time you speak the *y* sound of the word *memory*. However, a listener needs to retain this information about the pitch of your voice at the beginning of the sentence and compare it with similar information at the end of the sentence. The rising pitch in your voice allows the listener to decide that this sentence was a question. Listeners also need to retain an entire sentence so that they can determine which word in the sentence is stressed. Notice, for example, how the meaning of the sentence "I wouldn't buy tickets to hear him sing" changes, depending upon whether you stress the I, the buy, the him, or the sing.

A second reason why we need sensory memory is that we need to keep an accurate record of the sensory stimulation for a brief time while we select the most important stimuli for further processing. You would be overwhelmed if you noticed all the information from all of your senses all of the time. Instead, your sensory memory keeps a record of the stimuli for a few moments, and the stimuli are quickly examined to determine which ones will receive further processing.

## C.2 Encoding in Sensory Memory

Getting information into sensory memory is a straightforward process. In visual sensory memory, anything that we see enters, or is encoded in, the memory system. An auditory sensory memory is anything that we hear. There are probably separate sensory memory systems for each of the senses. In every case, the information taken in by the sensory system is stored in sensory memory for a very brief period of time. Sensory memory allows us to continue to see the images of a race car that passes us at 200 miles per hour or to continue to taste a delicious food for an instant after we have swallowed it.

Encoding in sensory memory is related to the process of transduction. **Transduction** is the process whereby sensory neurons transform stimuli from the environment into neural impulses that can be processed by the sensory systems and brain. In vision, light excites receptors in the retina that

transduce the information into neural impulses. The excitation on the retina lasts a few tenths of second after the image gone. A similar process occurs for each of the senses.

## C.3 Visual Sensory Memory (Iconic Memory)

Ulric Neisser, a major figure in the origins of cognitive psychology, proposed the name iconic memory to describe visual sensory memory. He wrote that iconic memory involves the brief persistence of visual impressions that "makes them briefly available for processing even after the stimulus has terminated". Whereas the term iconic memory refers to the memory process, the term *icon* refers to a particular visual impression, such as your impression of the letter A.

### C.3.1 Sperling's Research on Iconic Memory

When we discuss storage of information in sensory memory there are two important questions. First, what is the capacity of sensory memory? That is, how much information can be stored? And how long can this information be stored before it is lost or forgotten? The answers to these questions came from a series of ingenious experiments performed by **George Sperling.**

Sperling's objective was to measure the true size of iconic memory. To do this, he needed to overcome the long amount of time that participants required to report all the items in iconic memory. The **Whole report technique** instructs people to report everything they saw. But the time for report may have exceeded the brief time range of sensory memory. To overcome this problem, Sperling devised partial **report technique** which instructs people to report only a specified portion of the display.

The same chart of letters is exposed very briefly. After the chart has disappeared, participants hear a tone that indicates which portion of the display they must report. Specifically, if they hear a high tone, they report the letters in the top row; a middle tone indicates the middle row; and a low tone indicates the bottom row.

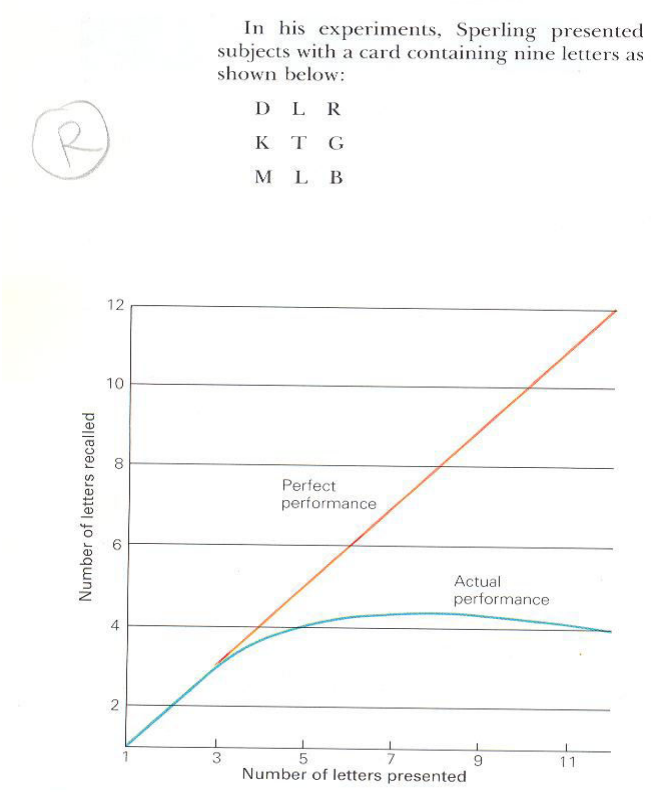



Figure 7.2
*Sperling's forgetting curve for sensory memory. (Based on Sperling, 1960)*

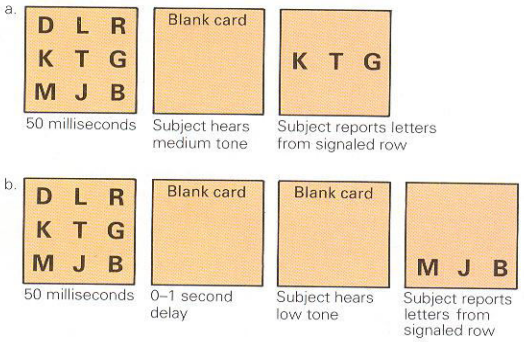


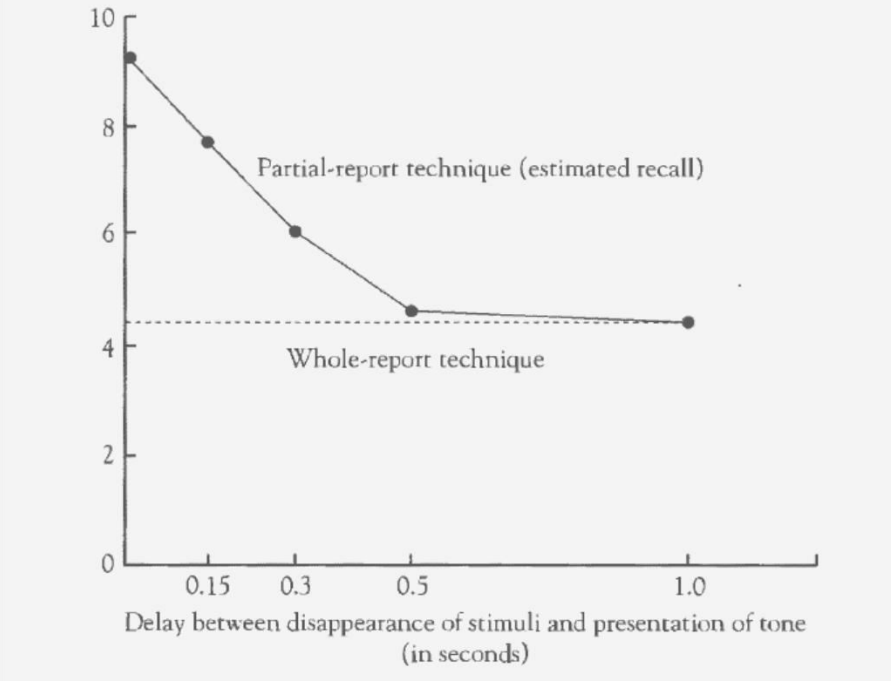

Figure 7.3
*(a) Sperling's partial-report method, and (b) partial-report method with delay.*

Subjects were allowed to view the card for only 50 milliseconds (1000 milliseconds equal 1 seconds). Sperling then asked the subjects to give a full report of all the letters they could remember. The most any subject could recall was four or five letters. In fact, no matter how many letters were on the card, the subjects could report only four or five letters. However, many subjects indicated that they initially remembered (saw) many more than four or five letters, but the memory faded so quickly that by the time they recited the first few letters the others were forgotten. In an attempt to verify these reports, Sperling modified his initial experiment. Once again he presented the nine-letter card to the subjects for 50 milliseconds. But instead of asking for a full report, Sperling asked for a partial report of only the first, second, or third row.

However, the subjects did not know *which* row they would be asked to report before the card had been removed. To indicate to the subjects which row they were to report, Sperling presented either a high, medium, or low tone immediately after the nine-letter card was turned off. The subjects were instructed that a high one tone signalled they were to report the top row, a medium tone signalled the middle row, a medium tone signalled the middle row, and a low tone signalled the bottom row.

To report a given row accurately, Sperling reasoned, the subject's sensory memories would have to include all nine letters. The results of the experiment showed that subjects had near-perfect recall no matter which row was signalled. These results verified Sperling's suspicion that all the information was actually stored in sensory memory but so briefly that some of the information was lost before the subjects were able to recite all the letters.

**Number of Letters Recalled, as a Function of Technique and Delay (Typical Results).**




With the knowledge that visual sensory memory was quite brief, Sperling next conducted a study to see exactly how long this sensory memory lasted. To accomplish this, he modified the partial-report procedure by varying the time between the presentation of the nine-letter card and the presentation of the tone indicting which line was to be recalled. If the tone occurred immediately after the nine letters, the entire image or sensory memory was available. But as the tone was delayed and the image faded, the recall of the letters became worse. Sperling found that even after one-tenth of a second the memory started to fade and after 1 second the sensory memory was gone. This fading or decay represents forgetting in sensory memory.

Sperling's results produced enthusiastic responses from cognitive psychologists. These findings were quire compatible with an information-processing approach, such as the Atkinson -Shiffrin (1968) model. As Long describes, the information processing approach emphasizes that perception is not an instantaneous result of stimulation. Instead, our visual experience is the product of a sequence of well-defined processes or stages, each requiring a measurable amount of time. Iconic storage permits a briefly presented stimulus to be prolonged, allowing for the next stage in information processing to begin.

### C.3.2 The Location of an Icon

Sperling's (1960) research initially produced enthusiasm, but in the last 20 years the concept of the icon has inspired both controversy and skepticism. One controversial issue, for example, is whether icons are stored in the visual receptors in the eye, rather than in some more central part of the brain.

Specifically, Sakitt (1976) argued that the icon is stored in the rods, the light receptors that are sensitive to black-and-white stimuli but not to colored stimuli. Sakitt and her colleagues have continued to support this position (e.g., Long, 1980; Long & Beaton, 1982; Sakitt & Long, 1979). However, Banks and Barber (1977) demonstrated that iconic memory contains color information, and so cones must also be involved in iconic memory. Furthermore, Adelson (1978) found that, if anything, cones were more helpful than rods in iconic memory.

Most psychologists believe, therefore, that icons must be stored at a higher level of visual processing than the receptors of the retina. Iconic memory appears to be a cognitive activity rather than something limited to a portion of the eye.

If the information is indeed stored in the retinal receptors, then a stimulus exposed for a longer time should probably increase the duration of iconic memory. No perceptual theory would suggest that iconic memory should decrease when the stimulus lasts longer. However, Di Lollo and his colleagues obtained a surprising and counterintuitive result. As stimulus duration is increased beyond about 10 milliseconds, the duration of iconic memory becomes progressively shorter! As Di Lollo (1992) explains, iconic memory is based on a period of information-processing activity. This period has a fixed duration, and the clock starts ticking at the very beginning of the stimulus presentation. In summary, Di Lollo's work suggests that the icon is stored in some more central part of the brain, rather than in the visual receptors of the eye.

### C.3.3 Usefulness of Icon and Iconic memory

- Motion pictures present brief flashes that need to be integrated in order to be perceived correctly; iconic memory aids this process.
- People spend considerable time looking at displays that resemble those used in laboratory experiments, and information about the icon can be useful in helping build more effective video display systems.
- The large-capacity storage provided in iconic memory is an extremely useful feature because, in combination with selective attention, it provides “a mechanism for people to retain only a portion of all the stimuli reaching their senses.
- iconic memory may help keep our visual world stable, despite constant eye movement

## C.4 Echoic Memory

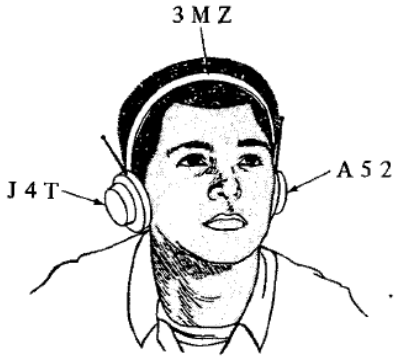
Neisser coined the phrase echoic memory to serve as the auditory equivalent of iconic memory. Echoic memory refers to auditory sensory memory, or the brief auditory impressions that persist after the

sound itself has disappeared. A particular auditory impression is called an ***echo***, because of its similarity to the echo that sometimes persists after a sound disappears.

### C.4.1 Darwin's Research on Echoic Memory

An important demonstration of echoic memory was a study modelled on Sperling's partial-report technique.

**A Person Participating in an Echoic Memory Study.**




Darwin, Turvey, and Crowder (1972) neatly reversed Sperling's study by presenting an auditory display and using a visual signal to cue the partial report. These authors used special headphones to present three different auditory messages to the participants. Figure illustrates how this was done. One group of items (J 4 T) was presented to a person's right ear. A second group of items (A 5 2) was presented to the left ear. A third group of items (3 M Z) was prepared by recording the list on both the right and left channels; this list was presented in such a way that it seemed to come from in between the right and the left ear-in other words, right in the middle. All three sequences were presented at the same time.

After hearing the sequences, people saw a visual cue on a screen, indicating which of the three sequences they should report. Specifically, a bar on the left meant that the participant should report the sequence from the left ear, a bar in the middle indicated the middle sequence, and a bar on the right indicated the sequence from the right ear.

Darwin and his co-authors found that the partial-report technique allowed people to report a larger estimated number of items than with the whole-report technique, in which people tried to report all nine items. These results are similar to the results for iconic memory. Thus, sensory memory stores items for a brief time so brief that this memory is gone before people can list all the items in their sensory memory.

#### *C.4.1.1 Difference between Iconic and Echoic Memory*

However, Darwin's study also pointed out some potential differences between the two kinds of sensory memory.

- The maximum number of items correctly recalled in echoic memory was estimated to be about 5, which is considerably **fewer** than the 9 to 10 items in iconic memory. Darwin and his coauthors speculated that echoic memory was relatively small because people had difficulty separating the three different input channels.
- Another potential difference between echoic memory and iconic memory may be their **duration**. Darwin's study estimated that echoic memory could last as long as 2 seconds, in contrast to Sperling's estimate of a fraction of a second for iconic memory. Further research by Crowder identifies the upper limit of echoic memory to be about 3 seconds, slightly larger than the 2 seconds specified by Darwin and his co-authors.

### C.4.2 Location of Echoic memory

Recently, neuroscientists are beginning to study echoic memory. Naatanen and his colleagues in Finland used the evoked potential method and tentatively located a site in the primary auditory cortex as the location of Echoic Memory. With additional research, we may be able to draw confident conclusions about the site within the brain where one component of echoic memory operates.

## D. Short Term Memory

We do not attend to all the information that impinges on our senses. Information that is attended to enters the second memory store called the short-term memory (abbreviated as STM), which holds small amount of information for a brief period of time (usually for 30 seconds or less).

Atkinson and Shiffrin propose that information in STM is primarily encoded acoustically, i.e. in terms of sound and unless rehearsed continuously, it may get lost from the STM in less than 30 seconds. Note that the STM is fragile but not as fragile as sensory registers where information decays automatically in less than a second.

A dual role for short-term memory is suggested. First short-term memory briefly stores information before the information is placed in long-term memory. Second, it briefly stores information that has been retrieved from long-term memory until the information can be verbalized or written. In both function, short-term memory is a working memory that contains the information we are using at the time.

## D.1 The Transfer from Sensory to Short-Term Memory

The transfer of information from sensory to short-term memory is governed by two control processes: pattern recognition and attention. These are called **control processes** because they regulate or control the flow of information between the memory storage systems.

### D.1.1 Pattern Recognition

Information held in sensory memory is called raw sensory information because it has not yet been analyzed for meaning. Before we can recognize a pattern of lines or dots as meaningful, we must first compare the pattern with patterns stored in long-term memory. This process of recognizing that information in sensory memory is familiar or meaningful is called **pattern recognition**. As information is recognized it is transferred to short-term memory.

As this model suggests, information in sensory memory has no meaning, but information in short-term memory does. To illustrate this point let's consider a simple example. Suppose the letter A is flashed on a screen.

Initially, the pattern of lines that make up the letter are stored in sensory memory. While it is held in sensory memory, the pattern is rapidly compared with other patterns that we are already familiar with. We then recognize this pattern as the familiar letter A and are even able to name it as such. As this naming process occurs, the information "letter A" is stored in short-term memory. Thus, as the information is transferred from sensory to short-term memory, it changes from meaningless lines to a meaningful letter.

### D.1.2 Attention

As we indicated earlier, sensory memory can hold a large amount of information, but short-term memory has a very limited capacity. Thus, only a small portion of the information in sensory memory

can be passed along to short-term memory. The control process that govern which information will go from sensory to short-term memory is called **attention**. Attention involves selecting the small portion of the information in sensory memory that will be passed along to short-term memory. As William James said in his first text book of psychology-

*Everyone knows what attention is. It is the taking possession by the mind in clear and vivid form, one out of what seem several simultaneously possible objects or trains of thought.*

The control process of attention may be illustrated by the "Cocktail-party effect". Recall that this involved the phenomenon of being able to attend to only one channel of information at a time. The point of this finding in regard to short-term memory is that even though we take in a tremendous amount of information in sensory memory, control processes such as attention determine what small portion of this information will be transferred into short-term memory.

## D.2 Encoding in STM

The information in sensory memory is encoded by an actual replica of the physical stimulus. But by the time the information gets to short-term memory it is encoded in a different way. Let's take the example of remembering a telephone number along enough to dial. One way to encode or represent the information in short-term memory would be to "see" a mental picture of the numbers. Another way would be to "hear" the numbers as you repeat them to yourself. Your own experience probably suggests that it is more common to repeat the number to yourself over and over than to actually see a visual image of the number. Research also indicates that most information is encoded through auditory representation.

However the acoustic code is certainly not the only code used in short-term memory. An item can also be coded in terms of a visual code, involving the physical appearance of the item, or in terms of a semantic code, involving the item's meaning.

### D.2.1 Kintsch and Buschke's Research – Acoustic Coding in STM

In one influential study, Kintsch and Buschke (1969) asked people to learn 16 English words in order. They proposed that the words from the beginning of the list would be in LTM when recall was requested because so much time had passed since they were presented. On the other hand, the most recent items should still be in STM.

Their study focused upon one distinction that duplex theorists had proposed: material in STM is coded in terms of its acoustic or sound characteristics, whereas material in LTM is coded in terms of its semantic or meaning characteristics.

The first study examined whether items at the beginning of the list-which were presumably in LTM would be influenced by semantic factors. The second study examined whether items at the end of the list-which were presumably in STM-would be influenced by acoustic factors.

The first list contained pairs of synonyms, which are words that are similar to each other in meaning (i.e. semantically similar list). After the material had been presented, the experimenters supplied one word from the list. The participants were requested to supply the next word in the list. Kintsch and Buschke measured the number of instances of semantic confusion that occurred for items in each part of the list. They found that Items at the beginning of the list produced a greater number of semantic confusions than items at the end of the list. This result suggests that items at the beginning of the list, which should be in L TM, are coded in terms of their meaning.

The second list contained pairs of homonyms, which are words that are similar to each other in sound (i.e. acoustically similar list). Kintsch and Buschke (1969) found that acoustic confusions were more likely at the end of the list than at the beginning of the list. This result suggests that items at the end of the list, which should be in STM, are coded in terms of their sound.

### D.2.2 Visual coding in STM

One of the most convincing illustrations of visual coding in short-term memory was a study by **Posner and Keele** (1967). In their experiment, people saw pairs of letters such as A-A, A-a, A-B, and A-b. Sometimes the two letters were presented at the same time, but other times there was a brief delay between the two letters.

In each case, people were requested to answer whether the letters had identical names or not. Posner and Keele were particularly interested to see whether people took longer to respond *yes* to A-a pairs than to A-A pairs. After all, if items are stored merely in terms of their sounds, then the response to A-a should be as fast as the response to A-A. However, if items are stored in terms of the way they look, then A-a pairs should take longer because the visual symbols must be translated into the appropriate names. A-A pairs, in contrast, would require no translation.

Posner and Keele found that when the delay between the two letters was less than 1.5 seconds, A-a pairs did indeed take longer than A-A pairs. However, when the delay was longer than 1.5 seconds, A-a pairs and A-A pairs took the same amount of time. Apparently, we initially code the pair A-a in terms of the physical appearance of the letters, but after 1.5 seconds the letters are coded in terms of the identical letter name, "Ay."

Thus, a visual code can be stored in short-term memory for very brief periods. However, this visual code seems to be quite fragile, because it is soon replaced by an auditory code.

### D.2.3 Semantic Coding in Short-Term Memory

We also have substantial evidence that items in short-term memory can be coded in terms of their meaning. For example, consider a study by Wickens and his colleagues (1976). Their technique is based on a concept from memory called proactive inhibition. **Proactive inhibition (PI)** means that people have trouble learning new material because previously learned material keeps interfering with new learning.

Suppose you had previously learned the items XCJ, HBR, and TSV in a Brown/Peterson & Peterson test of short-term memory. You will then have trouble remembering a fourth item, KRN, because the three previous items keep interfering. However, if the experimenter shifts the category of the fourth item from letters to, say, numbers, your memory will improve. You will experience a release from proactive inhibition; performance on the new, different item (say, 529) will be almost as high as it had been on the first item, XCJ.

Many experiments have demonstrated release from PI when the category of items is shifted, as from letters to numbers. However, Wickens and his coauthors (1976) demonstrated that release from PI could also be obtained when the semantic class of items is shifted. They showed that, meaning is important in short-term memory because old words interfere with the recall of new words that are similar in meaning. Furthermore, the degree of semantic similarity is related to the amount of interference.

## D.3 The Size of Short-Term Memory

Suppose a friend told you his age: 19. You would have no trouble remembering that. Furthermore, you would have little trouble remembering a four-digit street address, such as 2614. However, a standard

seven-digit phone number is more challenging-346-3421. If you add an area code to make the phone number 212- 346-3421, you are unlikely to remember the entire number correctly. Clearly, short-term memory is limited (Anderson).

During the early excitement about short-term memory, researchers were convinced that we could specify with great precision the number of items that could be stored in short-term memory. However, more recent research suggests that pronunciation time is another important determinant of short-term memory. We also know that the storage capacity of short-term memory is not a simple issue; factors such as anxiety influence the number of items that can be held in temporary storage. Incidentally, the final section of this chapter--on working memory-raises additional questions about the size of short-term memory.

### D.3.1 Miller's Magical Number

Researchers have been interested in the size of the memory span for more than a century. However, memory-span research gained particular importance in 1956 when George Miller wrote his famous article titled "The Magical Number Seven, Plus or Minus Two: Some Limits on Our Capacity for Processing Information." Miller proposed that people cannot keep many items in short-term memory at one time. Specifically, he suggested that people can remember about seven items (give or take two), or between five and nine items.

Miller used the term **chunk** to describe the basic unit in short-term memory. Thus, we can say that short-term memory holds about seven chunks. A chunk can be a single numeral or a single letter, because people can remember about seven numerals or letters if they are in random order. However, those numbers and letters can be organized into larger units. For example, perhaps your area code is 212 and all the phone numbers at your college begin with the same digits, 346. If 212 forms one chunk and 346 forms another chunk, then the phone number 212-346-3421 really contains only six chunks (that is, 1 + 1 + 4). It may be within your memory span.

### D.3.2 Pronunciation Time

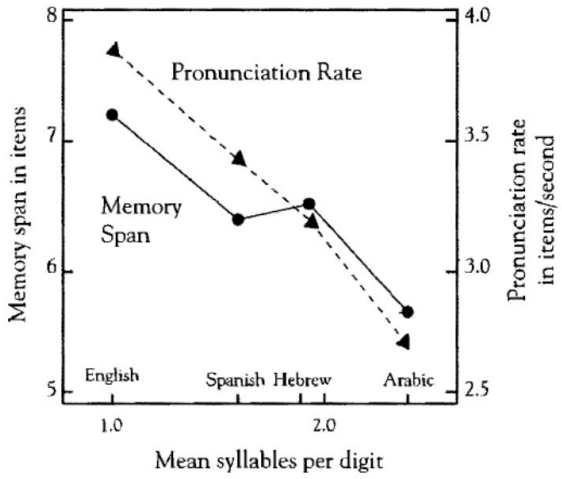
Other researchers have emphasized that pronunciation time may be even more important than the number of chunks formed by the items.

For example, Schweickert and Boruff (1986) tested memory span for a variety of materials, such as consonants, numbers, nouns, shapes, color names, and nonsense words. With impressive consistency, people tended to recall the number of items that could be pronounced in about 1.5 seconds. These authors propose that the capacity of short-term memory is not determined by a fixed number of items or chunks in memory; instead, it is determined by the limited time for which the verbal trace of the items endures.

In the case of nonsense syllables, a person might be able to pronounce only four items in 1.5 seconds; therefore, only four items will be recalled. In the case of numbers in the English language, a person can typically pronounce six items in 1.5 seconds, and so recall is somewhat greater.

Researchers have also tested the pronunciation-time hypothesis for other kinds of items. Baddeley et al found that people could accurately recall an average of 4.2 words from the list of countries with short names, but only 2.8 from the list of countries with long names.

**Memory Span and Pronunciation Rate for Numbers in Four Different Languages (Naveh-Benjamin & Ayres, 1986).**




However, the most systematic research has been conducted on the recall of numbers in a variety of languages. Naveh-Benjamin and Ayres tested memory spans for people who spoke English, Spanish, Hebrew, and Arabic. The English numbers between one and ten can be spoken rapidly; most of them are one-syllable words. Spanish and Hebrew have a somewhat greater average number of syllables for the numbers one to ten, and Arabic numbers are even longer. The memory span is significantly greater for people speaking English than for people speaking the other three languages. Furthermore, the dotted line shows the pronunciation rate for each of the four languages. As you can see, greater memory spans result from languages that can be spoken rapidly.

Clearly, both pronunciation rate and number of chunks needs to be considered when discussing the capacity of short-term memory.

### D.3.3 Anxiety and STM memory span

You probably will not be surprised to learn that highly anxious people have shorter memory spans than less anxious people. Darke (1988) administered a standardized measure, called the Test Anxiety Scale, to a large number of English speaking college students. He then selected for further testing the students who scored in either the top 20 percent or the bottom 20 percent of the scale. Students in the high-anxiety group recalled an average of 8.8 numbers, whereas students in the low-anxiety group recalled an average of 10.4 numbers, a statistically significant difference. Naturally, factors other than anxiety (for example, intelligence) might be at least partly responsible for the difference in recall. Still, one reason that highly anxious people often perform poorly on examinations may be that anxiety can limit their memory span.

## D.4 Duration of STM

If we repeat information in short-term memory over and over, it will remain there indefinitely. **Maintenance rehearsal** is the process of keeping information in short-term memory by repeating it. In the absence of maintenance rehearsal, information will remain in short-term memory only for **about 20 seconds**.

It has been shown experimentally that unrehearsed information remains in short-term memory for less than 20 seconds. These studies showed that if subjects were allowed to rehearse constantly, they could maintain information in short-term memory indefinitely. But if they were not allowed to rehearse, the subject began to lose information after 3 seconds, and forgot almost all the information after 18 seconds.

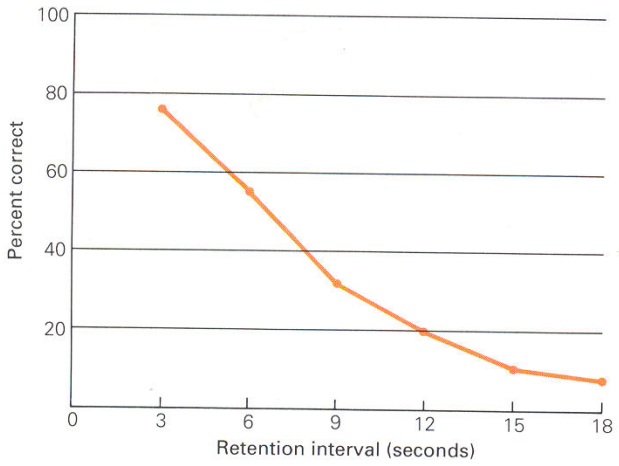



Figure 7.5
*Results of experiment on duration of short-term memory. (From Peterson & Peterson, 1959)*

To measure the duration of short-term memory, **Peterson & Peterson** used a distractor task, which prevents rehearsal. In this task, subjects performed the following series of trails. First, the subjects listened to a sequence of three consonants, such as TMS. Next, they heard a three-digit number, such as 271. As soon as they heard the number, subjects were to begin counting backward from the number by threes; 271, 268, 265, and so forth, for a certain period of time called the retention interval. The retention interval in this experiment ranged from 3 to 18 seconds. At the end of the interval, a signal indicated that the subjects were to stop counting and recall the three letters. Since the distractor tasks kept the subjects from rehearsing the three-letter trigram, this experiment provided an accurate measure of the length of time unrehearsed information remains in short-term memory.

## D.5 Retrieval from Short-Term Memory

How do we retrieve or get information from short-term memory? In other words, how do we scan the contents of short-term memory to find the chunk to information that we need? Scanning of short-term memory might occur in one of two ways. In the **parallel search process**, all the information in short-term memory is examined simultaneously. The alternative is a **serial search**, in which the information is examined one chunk at a time. Since short-term memory has such a small capacity, we might think that people use the first method. But research has indicated that subjects actually scan short-term memory one chunk at a time using a serial search pattern.

In the studies conducted by psychologist **Paul Sternberg** at Bell Laboratories, subjects were given a short list of numbers to remember. The length of the list ranged from one to five numbers. After the subjects were given the list, they were given another number, called the probe number. Their task was to indicate as quickly as possible whether the probe number was in the list. For example, If the original list was 5, 8, 3, 7, 9 and the probe number was 2, subjects should respond “no.” if the probe number was 7, subjects should respond “yes.” As the size of the list increased, subjects took more time to decide if the probe number was in the list. Such findings indicate that the subjects scanned the lit one item at a time, using a serial search. If the subjects had used a parallel-search method, that is, looked at all the items in short-term memory simultaneously, then it should have taken the same time to search no matter how many numbers were on the list.

A second important aspect of retrieval from short-term memory revealed by Sternberg’s research was the exhaustive nature of the search process. Even if the subjects found the item, say halfway through their search, they would continue to search the rest of short-term memory.

## D.6 Working Memory: A New View of Short-Term Memory

Earlier, we noted that many current researchers and theorists are proposing that neither iconic memory nor echoic memory is unitary. They argue, instead, that iconic memory and echoic memory each have at least two components. Therefore, you should not be surprised to learn that psychologists have also proposed several components for short-term memory. As Schneider (1993) emphasizes, multiple memory systems have evolved that are specialized for different tasks.

Alan Baddeley ( 1986, 1992) has developed the most complete description of a multicomponent interpretation of short-term memory, which he calls working memory. According to **Baddeley**, working memory is a three-part system that temporarily holds and manipulates information as we perform cognitive tasks.

Notice that Baddeley's working memory is not simply a passive storehouse with a number of shelves to hold chunks of information. His emphasis on the manipulation of information means that working memory is more like a workbench where material is constantly being handled, combined, and transformed.

Before we examine the three components, let's see why Baddeley felt compelled to conclude that working memory is not unitary. In a classic study, Baddeley and Hitch (1974) presented a string of random numbers and instructed people to rehearse them while performing a reasoning task. The reasoning task required participants to judge whether certain statements about letter order were correct or incorrect. For example, when the two letters BA appeared, participants should respond to the statement "A follows B" by pressing a "yes" button. If BA was accompanied by the statement "B follows A," participants should press the "no" button.

Imagine yourself performing this task. Wouldn't you think you would take longer and make more errors if you had to keep rehearsing eight numerals, instead of only one? In fact, Baddeley and Hitch discovered that people required less than a second longer when instructed to rehearse eight numerals, in contrast to a task that required no rehearsal. Even more impressive, the error rate remained at about 5 percent, no matter how many numerals the participants rehearsed! These data clearly contradicted the view that temporary storage has only about seven slots.

Instead, short-term memory or working memory seems to have several components, which can operate partially independently of each other. Baddeley proposed three components for working memory: a phonological loop, a visuo-spatial sketch pad, and a central executive.

### D.6.1 Phonological Loop

According to Baddeley's model, the phonological loop stores a limited number of sounds, and the memory trace decays within 2 seconds unless the material is rehearsed. Notice that this description is consistent with the information on pronunciation time. Because the material in the phonological loop is coded acoustically, items that sound the same are also confused with one another and are more readily forgotten.

Recent research by Martin (1993) provides neuropsychological evidence for a separate phonological loop. Martin tested a woman known as E. A. who demonstrated normal sentence comprehension. However, she showed a very specific deficit for remembering phonological information. For example, she could not retain words presented in Spanish. Apparently, the phonological loop is not critical for language comprehension.

### D.6.2 Visuo-spatial Sketch Pad.

According to Baddeley's model, the second component of working memory is the visuospatial sketch pad which stores visual and spatial information-much like how you use a pad of paper to work out a problem in geometry.

In the study by Brandimonte and his colleagues (1992), the people who were instructed to repeat *Ia-Ia-Ia* were presumably forced to use the visuospatial sketch pad because their phonological loop was busy repeating the syllable.

Like the phonological loop, the capacity of the visuospatial sketch pad is limited (Frick). If you try to solve a geometry problem on a scratch pad that's too small, you will make some errors. Similarly, when too many items are supplied to the sketch pad, you cannot represent them accurately enough to be successfully recovered. Keep in mind, however, that the limits of the phonological loop and the visuospatial sketch pad are independent. As Baddeley and Hitch discovered, you can rehearse numbers in the phonological loop while making decisions about the spatial arrangement of letters on the visuospatial sketch pad.

### D.6.3 Central Executive

According to Baddeley's model, the central executive integrates information from the phonological loop and the visuospatial sketch pad, as well as from long-term memory; the central executive also plays a major role in attention and in planning and controlling behaviour. Baddeley (1992) admits that the central executive is more difficult to study using research techniques, in comparison to the other two systems. However, it plays a critical role in the overall functions of working memory.

As Baddeley (1986) points out, if we concentrate on, say, the phonological loop, the situation would resemble a critical analysis of *Hamlet* that focuses on a minor character Polonius and completely ignores the prince of Denmark! Baddeley proposes that the central executive works like a supervisor or scheduler.

The executive decides which issues deserve attention and which should be ignored. The executive also selects strategies, figuring out how to tackle a problem.

Finally, like any competent supervisor, the central executive gathers information from a variety of sources. To continue this metaphor, the central executive in working memory synthesizes the information from the two assistants, the phonological loop and the visuospatial sketch pad, and also from the large library known as long-term memory.

## E. LONG TERM MEMORY

Although sensory and short-term memory systems are essential, we usually think about memory as the ability to store a tremendous amount of information for a very long period of time. This capacity is known as *long-term memory.*

Long-term memory is often compared to a reference book or even to a reference library –it holds a storehouse of information. It enables us to remember events that occurred as recently as 5 minutes ago or as far back as our early childhood. Everything we store for future reference is encoded into long-term memory. Thus, it is easy to understand why psychologists have devoted so much effort to understanding this memory system.

## E.1 The Transfer from Short-to Long-Term Memory

As was the case for the transfer of information from sensory to short-time memory, the transfer from short-to long-term memory is governed by a control process. The control process in this case is *elaborative rehearsal.*

### E.1.1 Maintenance and Elaborative Rehearsal

*Maintenance rehearsal* –the simple repetition of information –can be used to keep information is short-term memory for an indefinite period of time. This type of rehearsal, however, is not the most effective way to transfer information to long-term memory. In order to accomplish longer retention elaborative rehearsal, is best. **Elaborative rehearsal** involves analyzing the meaning of the view information and relating it to information already in long-term memory. Elaborative rehearsal can be considered "mental work".

A study by **Fergus Craik** and **Endel Tulving** (1975) demonstrated that the more elaborate the rehearsal, that is the more we analyze the material for meaning, the better the recall. To demonstrate this to yourself, try the following experiment, which is very much like Craik and Tulving's .

First, read the list of words given below. Then, answer the following questions about the first words in the list. Only answer each question once, and when you have finished a question do not go back to it.

TREE, CAR, bear, TOP, book, PEN

1. Is each word printed in capital or small letters?
2. How many letters does each word have?
3. Does each word rhyme with care?

Now answer the next three questions about the last three words in the list.

1. Is the word a noun or a verb?
2. Give a synonym for the word.
3. Does the word fit into any of the following sentences?

The child spun the_____.

She took the _____ to school.

He wore a _____ hat.

Now, without looking back at any of the words, recall as many as you can.

If you behaved like the subjects in Craik and Tulving's experiment, you probably recalled more words form the second group than from the first. This is because the question about the second list required you to attend to the *meanings* of the words. These questions involved parts of speech, synonyms, and whether the words made sense in a sentence. On the other hand, the questions pertaining to the first group required you to attend only to the words' *physical characteristics* (type and number of letters) and their *sound* (whether they rhyme with another word).

### E.1.2 Automatic Processing

As most students know and as Craik and Tulving's experiment showed, transferring information to long-term memory requires effort. Learning the material in this chapter for an upcoming test, for example,

requires a good deal of elaborative rehearsal. But does this mean that only elaboratively rehearsed information can get into long-term memory?

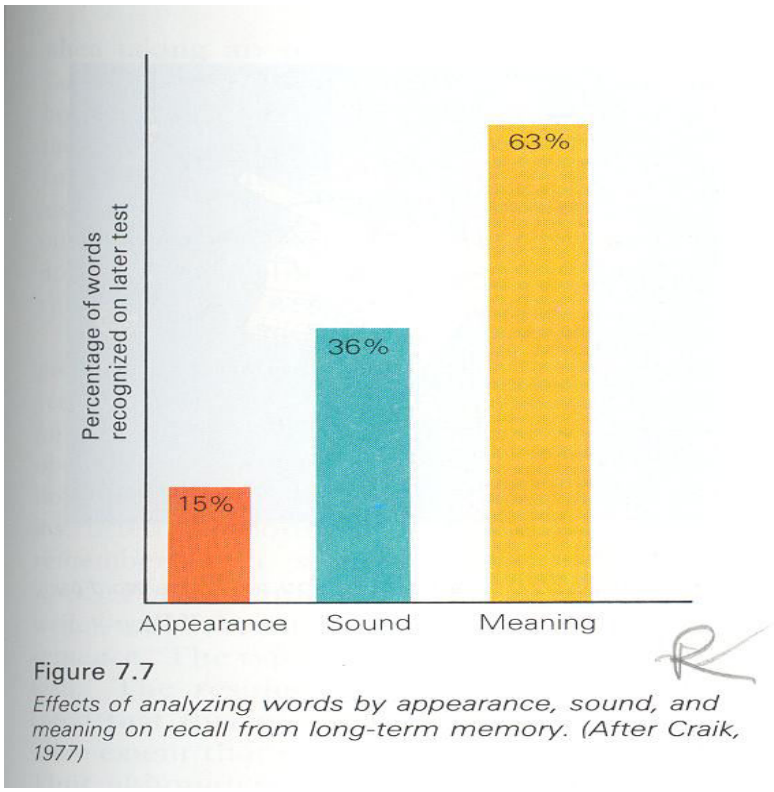



Figure 7.7
*Effects of analyzing words by appearance, sound, and meaning on recall from long-term memory. (After Craik, 1977)*

Recently psychologists have learned that some information can be transferred automatically to long-term memory. **Automatic processing** involves an effortless transfer of information to long-term memory. It is not under conscious control. For example, you do not actively rehearse the places you have visited during the day so that you can recall them later. You probably can recall quite accurately the places you went yesterday. Perhaps the best example of this type of effortless recall occurs when you lose something and must mentally retrace your steps to find it.

Automatic processing has also been demonstrated in the laboratory. **Lynn Hascher** and **Rose Zachs** showed subjects a long list of words. Subjects in one group were told that they would be asked to remember how many times a particular word occurred. Subjects in a second group were given no such instruction. Yet they remembered as well as the subjects who were warned. These studies suggest that certain information, such as how often something occurs, does not require effortful processing to remember; it is transferred automatically to long-term memory.

## E.2 Encoding in Long-Term Memory

Anyone who has ever memorized a poem word knows that we sometimes encode literal representations of information. However, most of the information stored in long-term memory is encoded by meaning. Meaning can be encoded in one of two forms: semantic coding or imagery coding.

**Semantic coding,** remembering the general meaning of words and sentences, is probably the most familiar method. For example, a few minutes after hearing a sentences, all we can recall is the meaning or the main idea of the sentence, not each word. **Jacqueline Sachs** (1967) demonstrated this phenomenon by having subjects listen to the sentence "The good guy shot the bad guy." A few minutes later, after hearing a series of other sentences, the subjects were presented with slightly different forms of the original sentence to see if they could recognize the changes. Sachs found that the subjects could not tell the differences between the original sentence, "The good guy shot the bad guy," and a

rearranged sentence with the same *meaning,* "The bad guy was shot by the good guy. "This indicated that the subjects were not storing the sentences *verbatim* (word for word), but rather they were only storing the meaning. You might demonstrate this to yourself by trying to recall the poem "Mary's Lamb" (you may know it as "Mary Had a Little Lamb"). You probably cannot recall the entire poem word for word, but you can recall the meaning or gist of what happened in the poem.

A second way to encode meanings is **imagery coding** or creating a mental image of an object or a scene. To illustrate the difference between the two methods, consider how we might encode the meaning of the sentence, "The big dog caught the biscuit thrown by its master." If we encode its meaning by remembering the gist of the sentence, we would be using semantic coding. If we formed a mental image of a person throwing a biscuit and a big dog catching it, we would be using imagery coding.

Evidence indicates that both semantic and imagery coding are used in long-term memory. Our everyday observations suggest a semantic code, and this is supported by laboratory experiments like Sachs'. That we also encode information through imagery becomes obvious if you try to recall what the person sitting next to you in your last class was wearing. To accomplish this you probably had to conjure up an image.

It is not clear whether semantic or imagery coding is more effective. A series of experiments conducted by **Alan Paivio** suggests that images may be easier to recall than words. The following demonstration is quite similar to Paivio's experiments. Try to memorize the seven pairs of words given in List A below. You should spend no more than five seconds memorizing each pair. Once you have examined a pair, do not return to it. After you have memorized the list of pairs, cover the first column and try to remember the second. Record your results.

| **List A** | | | **List B** | | |
|---|---|---|---|---|---|
| Calculator | - | Bookshelf | Typewriter | - | wall |
| Poster | - | Check | Television | - | magazine |
| Book | - | Pencil | Notebook | - | crayon |
| Lamppost | - | shutter | Telephone | - | roof |
| Knife | - | fireplace | Fork | - | table |
| Stamp | - | ribbon | Coin | - | dresser |
| Shoe | - | notebook | Shirt | - | frying pan |

Now try the same for the pairs in List B, but this time use the following imagery systems to improve your recall. For each pair, conjure up an image that contains both items in the pair. For example, for the pair typewriter-wall, you might think of a typewriter hanging on a hook on a wall, or perhaps a picture of a typewriter painted on a wall. Since some evidence indicates that the more unusual an image the better the recall, you could be even more creative and see, for example, a typewriter being splattered into pieces against the wall. Again, allow only 5 seconds per pair, and be sure to create images.

After memorizing the pairs, cover the first column and test yourself. If you performed like the subjects in Paivio's experiments, you probably did better on the list in which you used imagery. Experiments like this suggest that imagery is a more effective memory system.

Imagery has also been used outside the laboratory to help remember things in everyday situations. One of the most interesting examples of the use of imagery in memory concerns **John Conrad**, a waiter in Boulder, Colorado, who once took 19 complete dinner order, never wrote down a single item, and delivered each order to the right person with out error. Conrad had to remember all the entrees, salad dressing, types of potatoes and vegetables, how each cut of meat should be cooked, as well as all the special request (hold the salt and bring some extra mushrooms please). Moreover, this feat was not an isolated instance. Conrad always works with his memory alone-never a pencil or pad.

Can Conrad do this because he has a superior memory? Laboratory research using Conrad as a subject indicated that he has just an average memory but has learned to use it very efficiently. One of the technique that he routinely uses is imagery. When memorizing an order, he begins by using imagery to associate the entrée with the customer's face. For example, when taking an order for a Boulder steak, Conrad might take note of the customer's beefy set of jowls; combining the steak with the "beefy" jowls, he forms an image. He then goes on to make further associations, often though imagery, between other parts of the meal and the entrée. By doing this he is able to use an average memory in a highly efficient manner.

We should point out that not all psychologists agree that imagery is the key to better recall. Similar improvements in recall for word pairs can be obtained without using imagery. In a variation of Paivio's experiment, subjects were instructed to connect each word pair by remembering a sentences that used both words. For example, for the word pair "typewriter-wall", the subjects might remember the sentence "The typewriter was hanging on the wall." The results of this experiment indicated that this method helped recall to the same extent that imagery did. Thus, although psychologists do not agree on whether images or sentences are a better way to encode lists of words, they do agree that the critical factor is forming relationships or associations among the material to be learned.

## E.3 Storage in Long-Term Memory

Because long-term memory stores so much information, one question that has intrigued psychologists is how information in this warehouse of knowledge is stored. Although this is a difficult question to answer, psychologists have recently begun to unravel the puzzle. Psychologists now believe that information stored in memory can be broken down into two basic types: procedural and declarative.

### E.3.1 Procedural Memory

**Procedural Memory** is sometimes called "skill" memory. It is our knowledge of how to do things. Example of procedural memory include riding a bicycle or touch typing. Skill memories are memories of actions and are acquired by practice or observation. Procedural memories are pieces of information in long-term memory that cannot be inspected consciously. Riding a bicycle is a complex skill that most of us can perform, but if we try to explain how we do it, we will give a sketchy description as best. Similarly, we speak grammatically correct English, but most of us to do so. Indeed, describing the task is usually much more difficult than performing it. You may have had the experience of approach a combination lock that you had not opened for sometimes. You experience a brief moment of panic because you cannot recall the numbers in the combination. But when your fingers touch the lock, they turn automatically to the correct numbers. The combination was stored as a procedural memory.

Though the combination was not consciously available, you had the skill or procedural memory necessary to open the lock.

### E.3.2 Declarative Memory

**Declarative or fact memory**, in contrast, is memory for specific information. How did you celebrate your sixteenth birthday? Who was the first president of the India ? **Canadian psychologist Endel Tulving** has suggested that declarative memory can be broken down into two types: episodic and semantic.

#### *a) Episodic Memory*

Episodic memory is an autobiographical memory system responsible for storing a record of the events of our lives. It allows us to answer such questions as what movie did you see last Saturday night or what did you have for lunch today? As its name suggests, it noted individual episodes of your life. This memory system stores internal representation of personal events. Its distinguishing characteristics is that each event is identified by the time and place that it occurred. It is this system that allows us to travel back in time and remember the time and place of our fifth birthday party or our first experience on a roller coaster.

#### *b) Semantic Memory*

Semantic memory stores more general information about the world such as rules, concepts, and facts. The crucial distinction between semantic and episodic memory is that whereas episodic memories are linked to a particular time and place, the date and place of your fifth birthday party for example, semantic memories contain knowledge, but with no reference to when or where it was acquired. For example, what is the capital of Russia? This is a piece of information that most of us have, but chances are you do not know when or where you learned this fact. It is a semantic memory : a piece of information that you have but cannot tell where or when you learned it.

## E.4 Retrieval from Long-Term Memory

Each of us has stored a tremendous amount of information, perhaps millions of items, in long-term memory. One of the most intriguing questions regarding this vary memory storehouse is how we find any one piece of information.

Recall that to find a piece of information in short-term memory subjects searched through every item, one by one. But if we used a similar strategy for searching through long-term memory, it could take days, weeks, or even years to locate a single piece of information: one source estimates that it would take 400 years to answer the question “What is your name?” There must be a more efficient strategy for searching long-term memory.

The ability to find information relies on two important principles, the organization of long-term memory and the use of retrieval cues.

### E.4.1 Organization

Let’s consider long-term memory as a library of personal information. This analogy is helpful because one thing we associate with libraries is a highly organized collection of books. But imagine for a moment a different types of library: a library in which books were placed on the shelves in the order in which they were received or even at random. Imagine trying to find any particular book in such a library. With no organizing principles for this store house of knowledge, we would have to search through the books one at a time, growing old before we finished many term papers. Fortunately, material in a library is organized in a way that simplifies retrieval. First, the library is organized so that related materials are stored in the same general location. Second the card catalogue organizes information by author, title,

and subject. There is now good evidence that long-term memory is organized in a similar way----related material is stored together or associated. This organization is what makes rapid recall possible.

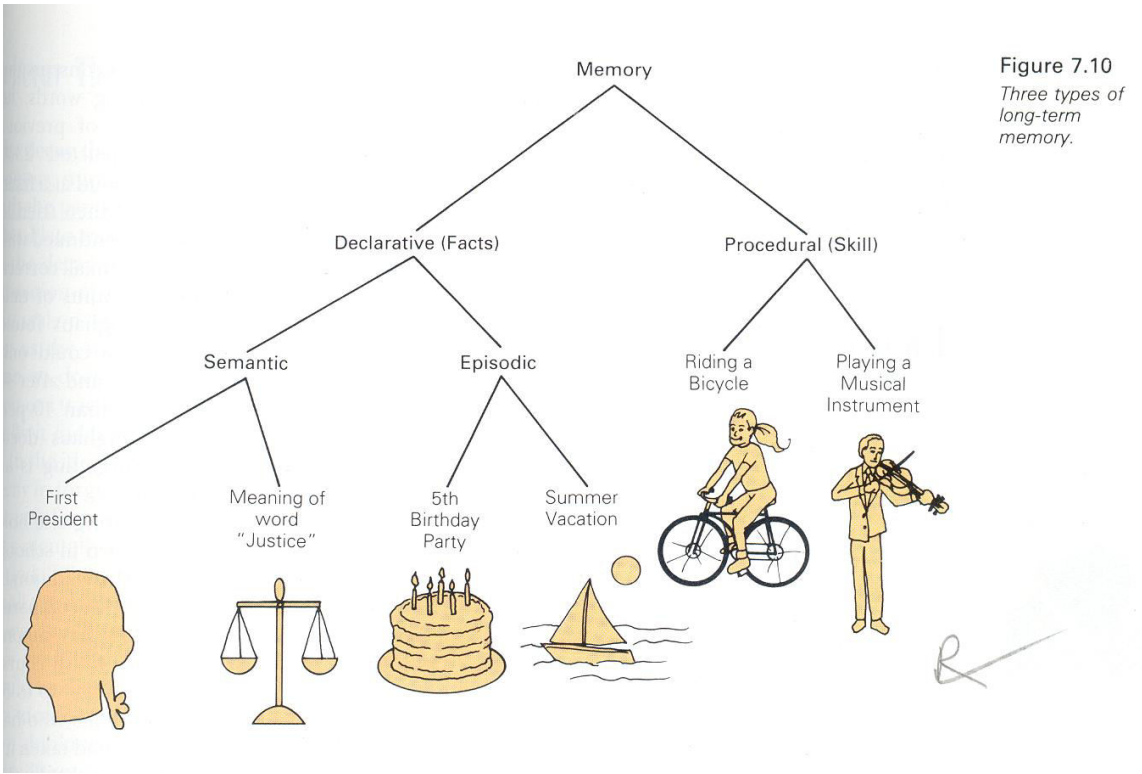



Figure 7.10
*Three types of long-term memory.*

In an early study on memory subjects were given a list of 60 words to memorize. The subjects were not told that the words fell into 4 categories: animals, vegetables, professions, and names. The 60 words were given to the subjects in a random order. When the subjects were asked to recall the list in any order they liked, they grouped the words into the 4 categories. Other studies have shown that even when the items in the to-be-remembered list did not fall into natural categories, subjects created their own.

This research showed that information was stored a highly organized way and that this facilitated recall. Additional evidence that memory is stored in a highly organized way comes from a fascinating clinical case. Two years after suffering a stroke, the patients M.D. appeared to have made a complete recovery except for one curious problem. He could not remember the names of fruits or vegetables. Moreover, he could sort pictures of animals, types of food, or vehicles into proper categories, but he could not do the same for fruits or vegetables. This case provides further evidence that related information in memory is stored together, perhaps in specific areas of the brain. Indeed there are now entire models of memory that show precisely how related information may be linked in long-term memory.

### E.4.2 Retrieval Cues

If information is organized so that related information is stored together, certain cues called retrieval cues should help in recalling information. **Retrieval cues** are defined as stimuli that help locate information in long-term memory. For example, what if you were asked to remember the names of all the states? There are a number of strategies you might use to accomplish this. One way in which you would not go about doing this is to search through every item in your memory until you found the 27 states. Rather, you would use a strategy to search you memory. You might begin by identifying a geographical area, the Northeast, for example, and try to identify all the states there. This would be followed by all the other geographical areas. Another strategy might be to pick one state and then try to remember all the states that border it and then all the states that border those states. Indeed you might use any number of strategies to search long-term memory. But these strategies all have one thing in

common; they require that memory be well organized. In the case of remembering states, all the state in the Northeast may be stored together. Remembering one makes it easy to recall the rest. In an organized system like this, once we have a starting point or retrieval cue, it is relatively easy to remember related information. Let's now examine some of the research on the role of retrieval cues in facilitating memory search.

In one study, experimenters read category names along with words that fit into them to the subjects. For example, the category ANIMAL might include the words horse, pig, dog, and mouse, and the category PRESIDENTS might include Rajendra Prasad, Neelam.S.Reddy, Jail Singh, A.P.J. Kalam etc. Each subjects was given a total of 48 words, divided into 12 categories. The subjects were told that they did not have to remember the category names, only the words. Later, half of the subjects were asked to write down all the words that they could remember. The remaining half of the subjects were also asked to recall all the words they could but they were given the list of the categories. Subjects who were given the category names, a retrieval cue, recalled many more words.

The results of such studies indicate that we can facilitate retrieval by the way we store information in long-term memory. By carefully organizing material when it is stored the information becomes easier to retrieve, provided we are given a place to start our search.

## F. FORGETTING

We consider memory to be the ability to store information so that it may be recalled at another time. In any discussion of memory, we must also consider the failures of memory-forgetting. Forgetting is the inability to recall a particular piece of information accurately. Forgetting can be a problem at times, but it also serves a useful purpose. In this section we will consider the reason psychologists have identified for getting. We will conclude by discussing a fascinating clinical case of a person who could not forget.

**Herman Ebbinghaus** was one of the pioneers in memory research. He performed his studies over 100 years ago with particular interest in forgetting. Using himself as the only subjects, Ebbinghaus studied nonsense syllables-three-letter syllables consisting of a vowel sandwitched between two consonants. By carefully constructing these syllables to avoid forming words, he hoped to minimize the effects of previous knowledge. Ebbinghaus constructed 2300 nonsense syllables, read them aloud at a fixed pace in groups of 7 to 36, and then tried to recite them from memory. He continued with each list until he could recite them all correctly. He then waited varying amounts of time and tested his memory. Ebbinghus found that even after 20 minutes he could only remember 58 percent of the list and after 48 hours he could remember less then 40 percent. Ebbinghaus documented what we all know: forgetting is an important aspect of memory.

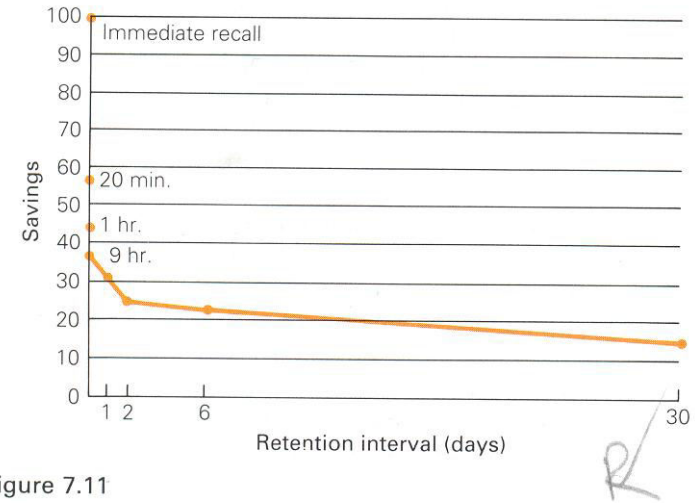



Figure 7.11
*Ebbinghaus' forgetting curve. (After Ebbinghaus, 1885)*

Does this rapid rate of forgetting also hold true for the information we learn in school? Apparently so. Continuing in the tradition of Ebbinghaus, **Harry Bahrik** compared a knowledge of Spanish vocabulary

among people who had just taken a Spinach up to 50 years ago. Compared with students who had just taken the course, those who had taken it 1 to 3 years ago had forgotten much of what they had learned. But after about 3 to 5 years forgetting stopped, even if the subjects had not taken Spanish at all for 50 years.

Why, like Ebbinghaus and the students in Bahrik's study, do we forget? Psychologists have proposed three major views.

**(i) Decay Theory**. Memory of an item spontaneously faded or decays with the passage of time. Nothing other than the passage of time is necessary. It is as if the pages of a book in a library have faded.

**(ii) Interference Theory**. Other memories interfere with the memory we are trying to recall. It is as if other books have been pilled upon the library book we are looking for.

**(ii) Retrieval Failure**. The information is there but cannot be located because the proper cues are not present. It would be like searching for a book in a large library without the proper aids, perhaps because the signs directing you to the proper shelf have been removed.

## F.1 Decay Theory

The **decay theory** of forgetting states that the memory trace spontaneously fades or decays with the passage of time. The Greek philosopher Plato was one of the earliest proponents of the decay theory. Plato likened the initial formation of the memory to a fresh imprint of a seal on a block of wax. Plato argued that, just as the wax imprint loses its shapes over time, so does the memory trace. At first the memory trace loses its sharp detail, and eventually it fades beyond recognition.

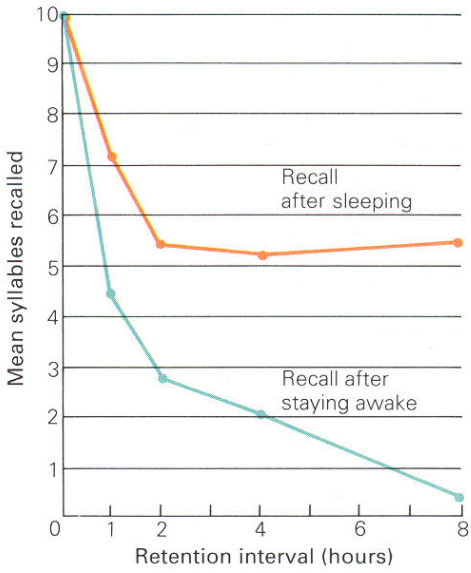



Figure 7.12
*Mean number of nonsense syllables recalled by subjects as a function of number of hours asleep or awake after learning. (After Jenkins & Dallenbach, 1924)*

In the ideal experiment to study the role of decay in forgetting, we would have the subjects learn information and then do noting their mentally for a certain time period. Then we would ask the subject to recall the material. Since the subject performed no activity and thus nothing could interfere with the information, any forgetting would be due to decay. As you might imagine, this ideal experiment is impossible. Nevertheless, psychologists have attempted to approximate it in order to study forgetting.

One of the most interesting attempts was an early study by **John Jenkins** and **Karl Dallenbach** in which two subjects were tested several times. Each subject first learned a list of 10 nonsense syllables like those used by Ebbinghaus. In one condition, each subject then went to sleep immediately, a situation that Jenkins and Dallenbach felt approached the ideal "do nothing" state. In a second condition, the subjects continued with their normal waking activities. After varying retention intervals of 1,2,4, or 8 hours, each subject was asked to recall the nonsense syllables. When the subjects went to sleep they could recall much more information. Based on this study, Jenkins and Dallenbach concluded that "forgetting is not so much matter of decay of old impressions and association as it is a matter of interference, inhibition, or obliteration of the old by the new."

These results certainly do not mean that decay plays no role in forgetting. Subjects who went to sleep did forget some of the material. However, it appears as though factors other than decay, such as interference, are primarily responsible.

## F.2 Interference Theory

According to **interference theory** other memories interfere with the retrieval of the particular memory we are searching for. Imagine that you are at a party and a very attractive person gives you his or her phone number. You can't find a pen to jot down the number, so you try to remember it. You rehearse it and place it in long-term memory. In the course of the evening you see other friends. One of them knows of a place on the beach that you can rent next semester for only Rs.5000 a month. The person gives you the phone number and again you store it in long-term memory. The next evening you decide to call the person that you met at the beginning of the party. You try to remember the phone number, but all you can remember the phone number of the beach house. The beach house phone number has interfered with recall of the person's phone number. This type of interference is called **retroactive inference**, meaning that new information interferes with the recall of old information. In our cases, the newer information of the beach house phone number interfered with your ability to recall the person's phone number.

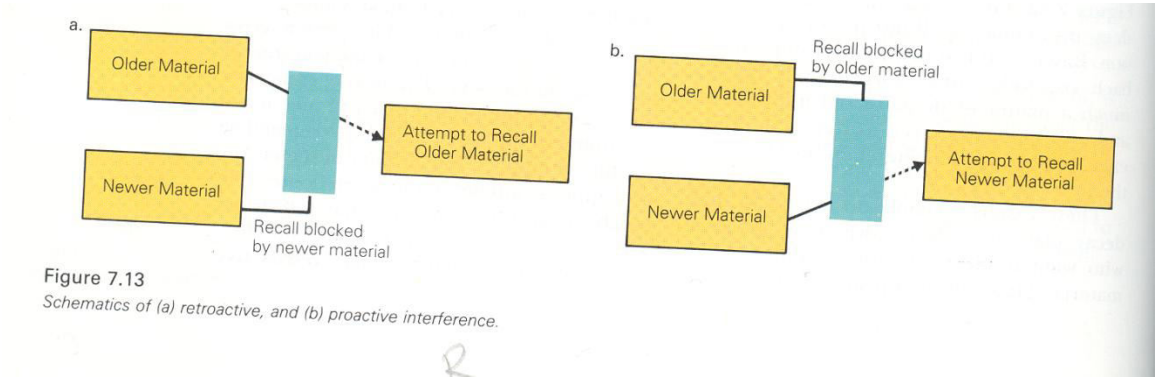



Figure 7.13
*Schematics of (a) retroactive, and (b) proactive interference.*

A second type of interference is called **proactive interference**. Here, old information interferes with recalling new information. For example, many of you have probably had the experience of living in one place for a long time and then moving to a new neighborhood. One of the first tasks is memorizing you new telephone number. But the first time you try to recall your new number, all you can remember is your old number. In this case, the older telephone number interfered with the recall of the new number.

Retroactive and proactive interference have also been studied in the laboratory. Typically, subjects are asked to learn a list of nonsense syllables. In one task to measure retroactive interference, and interference group and a control group are used. Both groups learn one list of nonsense syllables, which we will call List A. Subjects in the interference group then learn a second list of nonsense syllables, List B, while the control group performs a task that should not interfere with List A, such as listening to music. Both groups are then asked to recall List A, as diagrammed below:

| **Interference** | **Control** |
|---|---|
| Learn A | Learn A |
| Learn B | Perform unrelated task |
| Recall A | Recall A |

Interference theory holds that learning List B should interfere with recalling List A and, as expected, the control group does much better when asked to recall List A. Presumably this is because the control group did not experience retroactive interference.

In a typical task to study proactive interference, the interference group learns List A, then learns List B, and then recall List B. The control group listens to music, learns List B, and then recalls List B, as shown below:

| **Interference** | **Control** |
|---|---|
| Learn A | Perform unrelated task |
| Learn B | Learn B |
| Recall B | Recall B |

As in the case of retroactive interference, the control group is much more successful during recall.

## F.3 Retrieval Failure

A third theory of forgetting, retrieval failure, agrees with interference theory that all the information in memory is still available. But it differs from interference theory in specifying why the memories cannot be recalled. Interference theory states that memories cannot be recalled because other memories interfere. **Retrieval failure** theory holds that memories cannot be recalled because the proper retrieval cues are not available. This view suggests that if the proper retrieval cues are provided, the missing information can be located. The **Tulving** and **Pearlstone** studied in which subjects were able to recall more words in a particular category when they were provided with the name of the category, supports the retrieval-failure theory. In this instance, the category name served as the missing retrieval cue.

Figure 7.14

*A summary of the results of many laboratory studies on proactive interference in which the number of previous lists varied. The names on the curve refer to researchers. (From Underwood, 1957)*

That retrieval cues are extremely important in recalling information was demonstrated in a now-classic study by **Roger Brown** and **David McNeil** (1966) that investigated the tip-of-the-tongue phenomenon.

We have all experienced this phenomenon, but no one has described it better than William James in the first textbook of psychology:

To study this frustrating phenomenon in the laboratory, **Brown** and **McNeil** presented college students with dictionary definitions of unfamiliar words and then asked the students to provide the words. For example, subjects were read the definition: "a navigational instrument used in measuring angular distances, especially of the sun, moon, and stars at sea. "Most of the subjects either knew the word or knew that they did not know it. But some experienced the tip-of-the-tongue phenomenon: they were sure they knew the word but could not recall it. Brown and McNeil found that in about 50 percent of the cases these subjects could give the first letter and the number of syllables in the word, but they could not recall it. They often offered words that sounded like the correct word, such as secant or sexton; or words that had similar meanings, such as compass or protractor, but not the actual word—sextant. These data suggest that the information is in memory and that it could be recalled with the proper retrieval cue.

We have seen that retrieval cues facilitate recall. According to one theory, the best retrieval cues have the fewest memories attached to them. If this theory is correct, then distinctive events should serve as the best recall cues. For example, if you were given a list of 20 fruits to remember, one of which was apple, the retrieval cue "fruit" would not be of much help in recalling apple. The cue is not distinctive. It is linked to all fruits in the list, not just the apple. But if the list consisted of 19 presidents and only 1 fruit—apple—then the retrieval cue "fruit" would be very effective. Fruit is now a distinctive cue. It is associated with only one thing. One of the most vivid examples of the association between distinctive cues and accuracy of recall concerns memory for everyday occurrences that are associated with important events. For example, in a study conducted in 1899, subjects had remarkable recollections of what they were doing when they heard that President Lincoln was shot. Similarly, many people remember where they were and what they were doing when President Kennedy was shot. Julia Child reported that she was "in the kitchen eating soup depoisson. "Tony Randall remembered being in the bathtub. Brown and Kulik have called these flashbulb memories to signify the distinctiveness that the recall cue of an important event can have.

## F.4 Benefits of Forgetting

We tend to think of forgetting as a problem. Forgetting the name of someone we met a few weeks ago can be embarrassing and forgetting information on a test can be disastrous. But in some cases forgetting may not be so bad. As James noted in his first textbook of psychology- "If we remembered everything, we should be on most occasions as ill off as if we remembered nothing". To appreciate the benefits of forgetting, let's look at the case of someone who could not forget.

Soviet psychologist Alexander Luria describes the case of a journalist "S" who could remember long lists of words and giant grids of numbers. S had the uncanny ability to remember details of books he had read and conversations he had had, even in childhood. But S's remarkable memory was also a problem. He could not forget. He remembered strings of numbers and other irrelevant information even when he did not want to. Images of lists of numbers and words distracted him and interfered with his working. Eventually, S was unable to work at his profession and supported himself by demonstrating his abilities for audiences.

This case highlights the dangers of what many of us would like to have—a perfect memory. But a perfect memory would not only help us remember things we would like to remember, it would also allow us to recall things that are better off forgotten. A certain amount of forgetting may be a very good thing.

To recap our discussion of the causes of forgetting, we note that forgetting can be attributed to three processes: decay, interference, or retrieval failure. Although experimental evidence indicates that interference and retrieval failure are the primary causes of forgetting, decay also appears to play a role in some instances. Rather than attempting to determine which of these is the cause of forgetting, it might be better to realize that they all can be sources of forgetting. We can then try to understand under what circumstance each process is likely to be operating.

## G. Memory in Natural Contexts

We now have a good understanding of how information passes through our memory systems. But let's stop for a moment and considers the kinds of information that we have been discussing and the way it has been researched. We have discussed letters, numbers, lists of words, and nonsense syllables—all researched in controlled experiments conducted in the laboratory. Within the last 10 years psychologists have recognized that this field of study is too narrow, that there is an entire untapped field of memory that should be studied.

Studying memory for nonsense syllables and lists of words has provided important information about the memory process, but what about memory for other types of information? How will you remember the short story that you read last night so you can discuss it in your literature class tomorrow? In this section, we will see that psychologists have begun to address this issue by studying memory for sentences, paragraphs, and even entire stories. As for studying memory only in the laboratory, what about memory in natural settings? For example, the Supreme Court has questioned the accuracy of the memory of eyewitnesses. Psychologists have responded by studying the memory of eyewitnesses, another topic for examination in this section.

### G.1 Memory for Natural Language

Most of the research that has been conducted on memory for natural language involves exposing subjects to a series of sentences, a paragraph, or a story and then asking them to recall the material at a later time. This research has indicated many similarities between memory for nonsense syllables and memory for natural language. For example, just as one nonsense syllable can interfere with the recall of other syllables, a sentence can interfere with the recall of other sentences.

But there are also some interesting differences between memory for nonsense syllables and memory for natural language. When subjects memorize a list of nonsense syllables, forgetting usually involves not being able to recall one or more syllables.

#### G.1.1 Constructive Memory: Memory is not only reproductive but constructive also

**Constructive memory** is the process by which we add to information stored in memory. When sentences are presented, listeners not only encode and store the meanings of the sentences, but also the implications the sentences suggests. They integrate the information in the sentences or story with their general knowledge about the world. In order to appreciate the processes by which memories are constructed, read the passage from Aesop's Fables in entitled "The Shepherd's Boy. "Now without looking back at the passage, recall what you just read from memory. Most people who are asked to perform this task give a summary of he article in their own words. It would be very unusual to recite the entire article back word for word. It would even be unusual to recite a few key sentences of the article word for word.

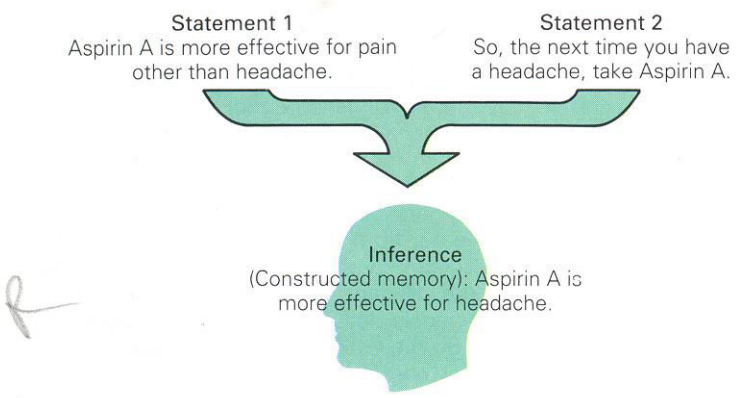

Statement 1
Aspirin A is more effective for pain other than headache.
Statement 2
So, the next time you have a headache, take Aspirin A.
Inference
(Constructed memory): Aspirin A is more effective for headache.

Figure 7.17
*Use of inferences on a television commercial. The advertiser hopes that the constructed memory is the one we store in long-term memory.*

***"The Shepherd's Boy" from Aesop's Fables.***

*There was once a young shepherd boy who tended his sheep at the foot of a mountain near a dark forest. It was rather lonely for him all day, so he thought upon a plan by which he could get a little company and some excitement. He rushed down towards the village calling out "Wolf, wolf," and the villagers came out to meet him and some of them stopped with him for a considerable time. This pleased the boy so much that a few days afterwards he tried the same tricks, and again the villagers came to his help. But shortly after this a wolf actually did come out from the forest and bean to worry the sheep, and the boy of course cried out "Wolf, wolf," still louder than before, but this time the villagers, who had been fooled twice before, thought the boy was again deceiving them, and nobody stirred to come to his help. So the wolf made a good meal of the boy's flock, and when the boy complained the wise man of the village said,* ***"A liar will not be believed, even when he speaks the truth."***

This simple demonstration reveals that meaning is an important aspect of our memory for natural language. We do not remember information on a word-for-word basis; rather, we remember only a summary or the gist of the passage, usually in our own words. But if we only remember the general idea of a passage how do we fill details? Since we have construct these memories. These constructed memories are based on both what we remember from the original passage (our summary) and what we already knew about the material in the passage before we read it (our general knowledge of the world). Now, without referring to the passage, try to answer the following question:

1. What did the boy call out to attract the attention of the villagers?
2. Was the base of the mountain a grassy meadow or a forest?

Reread the article to check the accuracy of your answers. The answer to the first question is in the fable and probably answered correctly. The answer to the second question, however, is not in the fable. To answer this question it was necessary for you to construct a memory, using both the information in the article and what you already know about sheep and grazing. The fable indicated the sheep were grazing at the bottom of the hill. You might already know that sheep typically graze where there is grass. If you combined the information from the fable that sheep were grazing at the bottom of the hill with what you already know about sheep, you could have constructed the memory that there was grass at the bottom of the hill. One process that helps us to construct these new memories is inference.

**Inference** is the process by which we fill in information missing from a story using general knowledge already stored in memory. There is now substantial evidence to indicate that when subjects read a series of sentences they store not only the meaning of the sentences, but also inferences drawn from the sentences. In one study subjects were asked to read the following statements

*A burning cigarette was carelessly discarded. The fire destroyed many acres of virgin forest.*

Later, the subjects were asked to indicate if the following statement was true or false:

*The discarded cigarette started the fire.*

Interestingly, 96 percent of the subjects regarded the statement as true, even though the original statement did not explicitly state that the cigarette started the fire. To reach this conclusion the subjects had to make the inference that the burning cigarette started the forest fire. The fact that carelessly discarded cigarettes often start forest fires is part of the information stored in the long-term memories of most people.

Inferences are often quite useful in helping us fill in missing pieces of information. But sometimes inference can be used to convey a false piece of information. One of the best examples of this is in television commercials. Several years ago an aspirin manufacturer presented a commercial promoting Aspiring A. The announcer stated that studies from a university and a leading hospital showed Aspirin A was more effective for pain other than headache. The commercial went on to present some other information about the product, and then the announcer reappeared saying, "So, the next time you have a headache, taken Aspirin A," Even though we were not told that Aspirin A was more effective for headache, most of us probably combined the information in the announcer's two statements to draw the inference that it was. In fact there is experimental evidence to indicate that subjects who listen to commercials often draw false inference about the advertised products.

### G.1.2 Distortion

Unlike constructions, **distortions** do not add information to memory; rather, they produce inaccuracies or changes in the material to be remembered. Distortions often occur when the incoming information is illogical or unusual. In these instance distortions produce memories that are more logical than the original input.

One of the best-known examples of distortion comes from a pioneering study performed by **Frederick Bartlett**. Bartlett had subjects attempts to reproduce a story they had read. The story, called "The War of the Ghost," was a legend about a tribe of North American Indians. When Bartlett's subjects, who were not Indians, tried to reproduce the story from memory, they made many predictable errors. Since the Indian legend seemed unusual and illogical to the subjects they considered to be a logical and orderly pattern.

According to Bartlett, the subjects distorted the memory because it did not fit into any existing schema that the subjects had. When individuals are placed in a situation many times they become familiar with various aspects of the situation. This general knowledge about that particular situations is called a **schema**. In Bartlett's study, the subject's schema for war was completely different from the account in "The War of the Ghosts." When they tried to fit the information in the story into their long-term memory, they "forgot" or distorted certain aspects of the legend that were incompatible with their schema.

Bartlett's views on distortion were well ahead of their time. But since his pioneering work, other studies have also shown distortion in memory. In one such study, subjects read a story about two friends of the

experimenter's Bob and Margie, who were engaged to be married. The story concerned Bob's desire not to have children. He had not yet told Margie about these feelings because he was afraid that she wanted children. When he finally told Margie, she stated that she did indeed want children very much. Thus, her wishes were incompatible with Bob's. Later, the subjects were casually told that Bob and Margie did marry and were happy. The information that they were happily married was, of course, inconsistent with their disagreement over having children. This in turn did not fit the schema that people who disagree on important, basic issues are unable to remain happily married.

To assess memory for the story, the experimenters had the subjects return to the lab after intervals ranging from 2 days to 6 weeks and asked them to recall the story. Interestingly, the subjects recalled the initial disagreement over having children as less severe than it actually was. The subjects in this study had distorted the story so that the initial inconsistency was resolved and the story fit their schema.

Before leaving the topic of schemata, we should point out that schemata do not always contribute to distortions of memory. In certain instances they actually help us remember. For example, stories may be difficult to understand unless we can fit them into their proper schema.

### *G.1.2.1 Schemata and Expert Memorizers*

Sometimes experts in a particular area seem to have remarkable memories for information in their own specialty. For example, the famous conductor **Toscanini** is reported to have had an extraordinary memory for music. Just before the start of a concert, an agitated musician appeared before him. The musician reported that the key for the lowest note on his bassoon was broken-how would he play the concert? Toscanini shaded his eyes, thought for a moment, and then said, "It's all right-the note does not occur in tonight's concert." Not only did Toscanini know every note for every instrument in that concert, but it has been estimated that the knew by heart every note for every instrument in about 250 symphonic works, the words and music for 100 operas, plus a volume of chamber music, cello and violin pieces, and songs. How could Toscanini memorize so much information? One view holds that experts can memorize information in their field because they already have well-developed schemata or frameworks to place the information.

A study by Chiesi, Spilich, and Voss demonstrated the role of schemata in memory. This experiment showed that people who knew a lot about baseball could remember more about a fictitious baseball game than those who knew less about the sport. Baseball knowledge was first assessed by a test used to divide subjects into high-and low-knowledge groups. Both groups were given an account of one half of an inning in a fictitious baseball game and were then asked to recall the information. Presumably because they could more easily map the new information onto their existing knowledge structure or schema, the high-knowledge subjects remembered significantly more.

Schemata may also be helpful to students. For example, you may have noticed that when you are first studying a subject it is difficult to learn and remember the new terms and concepts. Yet the more you study the subjects, the easier it becomes to learn additional information. Perhaps you have developed schemata for the material that help you to organize and remember the new information.

Although studies on schemata represent a new area of research in memory, you may recognize that the process is very much like the relationship between organization and retrieval in long-term memory. Schemata may be another method of storing information in highly organized ways.

## G.2 Construction and Distortion in Eyewitness Testimony

One of the primary assumptions of eyewitness testimony is that witnesses can accurately store and recall information about the crime that they have seen. This assumption may be one of the reasons that few types of evidence have more impact in a court of law than the testimony of an eyewitness. But the assumption that the eyewitness is like a videotape recorded, capable of recording and playing back an event exactly as it occurred, may not be valid.

As we have seen, construction and distortion produce inaccuracies in memory. Research by **Elizabeth Loftus** and her co-workers has shown that these processes can raise serious questions about the accuracy of eyewitness accounts.

One study conducted by two of Loftus' students involved the enactment of a fake crime. In this experiment, two female students entered the Seattle, Washington, train station. The two students left a large bag on a bench and then went away to check the train schedules. While they were gone, a male student reached in the bag, pretended to pull out an object and place it under his coat, and then quickly walked away. Upon returning, one of the female students cried out "Oh my God, my tape recorded is missing." she went onto say that her boss had loaned it to her for a special reason and that it was very expensive. The two women then began to talk to eyewitness cooperated and were willing to give their phone number in case their testimony was needed.

One week later, another student posing as an insurance agent called each of the eyewitnesses. The "insurance agent" asked the witnesses for whatever details they could remember and concluded the interview by asking "Did you see the tape recorder?" Although there was no tape recorder, half of the eyewitnesses remembered seeing it and most of them were able to recall details about the color, shape, and even the height of the antenna. Apparently, these witnesses had *constructed* a memory based on what had actually occurred and what they already knew about expensive tape recorders. The eyewitnesses also claimed they would be able to recognize the thief again.

In a related study, **Loftus** and **Zanni** showed that eyewitnesses' memories could also be *distorted*. In this study, 45 subjects were shown a short film depicting a car accident. After viewing the film, each of the subjects answered question about what they had seen. One critical questions involved the subjects estimates of the speed of the cars. One group was asked, "About how fast were the cars going when they hit each other? For other subjects this question was, "About how fast were the cars going when they smashed into each other?" for other, the verb hit was replaced with collided, bumped, or contacted. Subjects who heard the verb smashed gave the highest speed estimates, while subjects who heard collided, bumped, and hit gave progressively lower speed estimates. Those questioned with the word "contact" gave the lowest estimates.

Some psychologists have been critical of applying principles derived from laboratory studies to the courtroom and others have suggested that the experimental results themselves can be interpreted differently. Nevertheless, *these and other studies are important and influential because they suggest that the same construction and distortion that occur in laboratory situations may also be factors in natural settings.*

## G.3 Autobiographical Memory

The testimony of eyewitness has provided a valuable opportunity to study memory in natural settings. A second natural setting in which psychologists have recently become quite interested is autobiographical memory. How do people remember and forget the events of their own lives? Autobiographical memories are important. After all, our sense of being a unique individual is in large part due to the

unique memories we have accumulated through the years. But autobiographical memories are also difficult to study. Unlike the laboratory experiment in which the experimenter knows the material the subject must recall, it is difficult to anyone but the subjects themselves to know about their autobiographical memories. If we ask subjects to tell us about autobiographical memories, how do we know whether what they recall is accurate?

To overcome this problem, memory researcher **Marigold Linton** continued in the tradition of Ebbinghuas and used herself as a subject. Every day for six years she recorded on index cards at least two things that she did that day. In this way she maintained an accurate record of her autobiographical events to which she could later compare her memory for these events. Eventually she accumulated a diary of thousands of items. Some of the items were relatively important such as mailing the last draft of her book to the publisher, while other were trivial such as eating in a particular restaurant. To test her memory, once a month she randomly selected cards from the deck, noted whether she could remember the events on them, and then tried to date the memory.

Like Ebbinghaus, Linton found that *the older memories were more difficult to recall*. But unlike Ebbinghaus who found that *most memory for nonsense syllables was lost after only a few hours, Linton found that autobiographical memories dropped out at a much slower and more constant rate-about 5 percent of the memories per year.*

Why is autobiographical memory better than memory for nonsense syllables? Some researcher believe that autobiographical memories rely upon schemata and these schemata help organize the memories. For example, the schema of how events typically occur in a restaurant-you are seated, get a menu, order, eat, pay the check-may aid greatly in the recall of specific autobiographical memories for particular meals at particular restaurant.

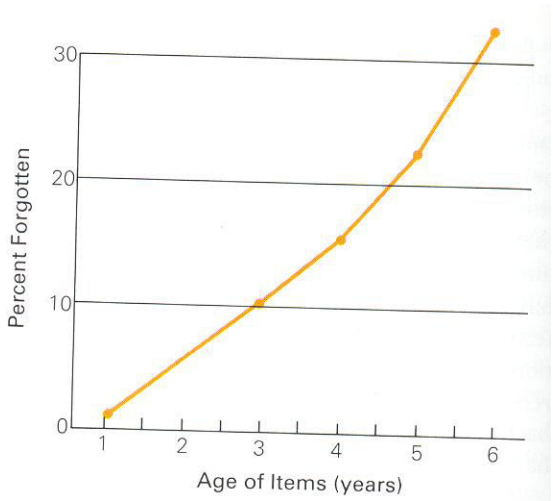



Figure 7.20
*Memory for autobiographical events. (After Linton, 1982)*

In a sense, the schema provides us with a grid in which to organize the specific autobiographical memories and we know how important organization is in recall.

## H. Improving Memory

**Williams James**, a pioneer in psychology and one of the earliest students of memory, believed that memory might be like a muscle that could be strengthened and improved through exercise. To test this idea, he first determined how long it took him to memorize a series of passage from a book. After

noting the results, he "exercised" his memory by memorizing Milton's Paradise Lost! He then retested his memory on a series of passages.

The results-no improvement.

James heroic demonstration indicates that simply using memory will not necessarily improve. But psychologists now know that using memory in certain ways will help. One method we have already considered is chunking information to aid short-term memory.

## H.1 Using Elaborative Rehearsal

We have already presented evidence, showing that the more elaborate the rehearsal, the greater the chance of retrieval. When we think about the meaning of word or try to associate it with other information already in long-term memory, we have a much better chance of recalling it than if we simply repeat the word or count the number of letters in it. Have you ever read a section in a book only to realize that even though you read the words, you do not remember a thing about the material? This is probably because you did not rehearse the information elaborately enough. One way to help guarantee rehearsal is to review the information. After each paragraph or section, try to restate what you have just read in your own words. You might even ask yourself question about the material. This will guarantee that you have thought about the meaning and processed the information.

## H.2 Periodic Retrieval

Reviewing the information as you are learning will help place the material in long-term memory but is probably not sufficient to ensure retention. Periodic retrieval of the material helps ensure that you will be able to accurately recall the stored information when it is needed. Periodic retrieval requires you to rehearse the material whenever the occasion arises. For example, if the term attention appeared in the next chapter, it would be beneficial to take a moment then and recall what you know about attention. This will not only facilitate recall at a later time, but it will also indicate if you need to review the material.

## H.3 Organization and Mnemonics

We have seen, one way to facilitate recall is to store information in a highly organized manner. Categories often help accomplish this. For example, one study has shown that organizing a list of words into categories enables subjects to recall nearly twice as many words.

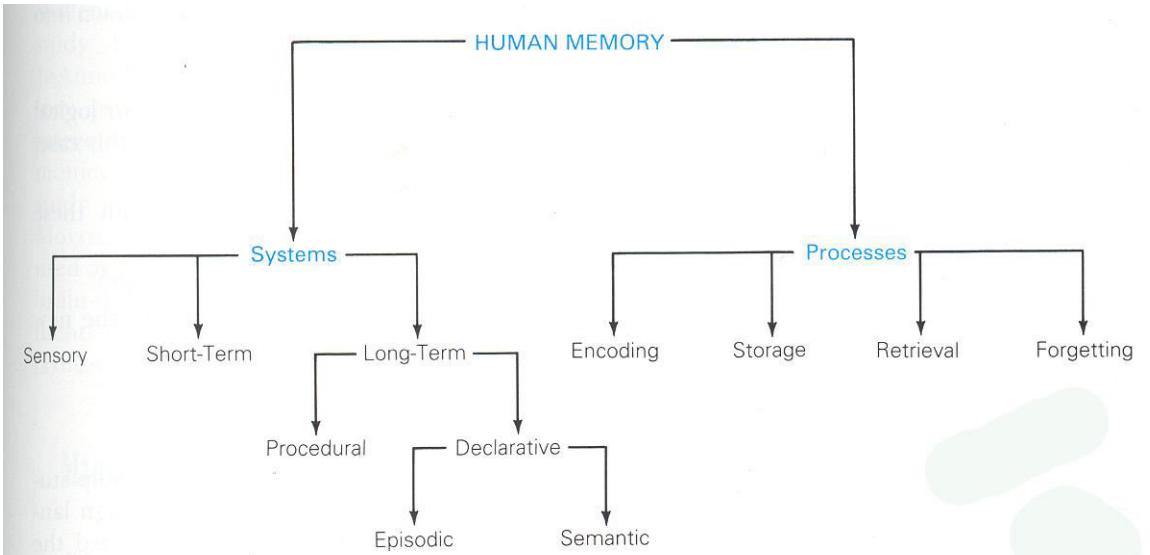



Figure 7.21
*A tree diagram of human memory systems and processes.*

Yet another way to help organize material is through the use of a mnemonic. A **mnemonic** is a technique for organizing information in long-term memory. Certain mnemonics are familiar to almost everyone., such as the rhyme "I before e except after c" to help remember a rule of spelling. Another is "Thirty days hath September, April, June, and November…." These mnemonics work because they organized the material into a logical framework-a rhyme-that is stored in memory as an organized unit. Rhyme is just one of the mnemonics that can help organize material. Two other methods are the method of loci and the keyword method.

### H.3.1 The Method of Loci

Although psychologists have begun to study mnemonics only recently, stage performers have been using them for hundreds of years. The following is a typical demonstration using mnemonics. The mnemoniest asks each member of the studio audience to name an item they have in their pocket. One such list might be:

Person 1 - lighter

Person 2 - pen

Person 3 - wallet

Person 4 - lipstick

Person 5 - nail file

Person 6 - nickel

Person 7 - photograph of grandma

Once the mnemonist has spoken to 20 people or more, he or she goes on to perform the rest of the act. Sometimes later the mnemonist tells each person in order the item he or she has named.

One method that the mnemonist might have used to accomplish this feat is the **method of loci**. This method involves imagining items to be remembered and associating each image with a place already stored in memory. Imagine that you are walking through your house. The first thing you might see is the door, followed by a coat rack, a mirror, a chair, a brass lamp, a red velvet sofa, and so on. What we have just described is a trip through a fictitious house, but it is relatively easy for you to do the same for your

own house. In doing so, you should identify the items in the order that you would see them. You now have a list already stored in long-term memory that can be used as the logical framework. Next, you must associate one new piece of information with each item on the list. One efficient way to do this is through imagery. To associate the first new piece of information, for example a lighter, with the first location in the house, conjure up an image of a lighter setting fire to the door. The next image might be a 5-foot pen hanging on the coat rack. You could continue this method until you had associated each item on the second list with something in your house. To recall the information on the second list, you simply take a mental trip through your house, recalling the images associated with each item in your house. This way, it is possible to recall 20 or 30 items in order, even after hearing each item just once.

- Most mnemonics can be broken down into several steps:
- There is known lit of cues, or logical framework, to work from (in this case, things in your house).
- New items are associated with these known cues.
- Association are made by images.
- The known cues aid recall of the new information.

### H.3.2 The Keyword Method

Mnemonics have also been used to help students learn the vocabulary of a foreign language. In this study, the students used the keyword method to associate Spanish words with their English equivalents. For example, the word albondiga is Spanish for meatball. To remember this the students could form an image containing both an albondiga and a meatball. But this would be difficult since the student has no idea what an albondiga looks like. This is where the **keyword method** comes in. First the student pronounces the foreign word and then tries to think of an English equivalent that sounds similar-the word bone, for example. Next, the student forms an image containing a bone and a meatball, perhaps a meatball the size of a beach ball with a 3-foot bone through it. Although this may seem like a strange way to learn foreign words, research indicates that students who used this method did over 200 percent better than students who learned in the traditional manner. With a little ingenuity, this method could be used to help learn almost any technical vocabulary. You might also use the keyword method to help you learn terms from this book. For example, by first using the keyword “hypo” and then forming an image of a hypodermic needle stuck in a hamburger, you might remember that the hypothalamus is an area of the brain that is involved in the control of feeding.

Mnemonics were once seen a type of “memory trick” not to be used by serious student. Perhaps this is the reason that despite the accumulating evidence that mnemonics facilitate memory, still relatively few students use them. Surprisingly, a recent study by Margaret Intons-Peterson and JoAnne Fournier found that introductory psychology student used mnemonics infrequently. Nevertheless, the study of mnemonics has become an important part of the study of memory. And mnemonics are being used as memory aids in groups ranging from brain-damaged patients with memory impairments to business executives.

## H.4 Minimizing Interference

We have seen, interference is one cause of forgetting. To improve the chances of remembering material, then, you should minimize interference. For example, if you have to study only history tonight. And when you have finished studying, the best thing to do is to go to sleep. Recall the Jenkins and

Dallenbach study in which the group that slept immediately after learning had much better recall. Apparently sleep minimizes interference.

## H.5 Context and Retrieval

It is easier to remember a particular even if you try to recall the event in the same context in which it was learned. The late novelist Nabokov told of a surprise visit he paid to his former tutor at Cambridge University. As you might imagine, his tutor had absolutely no idea who Nabokov was until Nabokov knocked over a tea tray, just as he had done when they first met. The tutor's memory of Nabokov, and everything about him, returned instantly.

Context can take on many forms. Places can serve as a context and can thus become a retrieval cue. If you learn material in a particular place, the best way to try to recall that material would be go to this place. For example, if you wanted to remember the name of the person who sat next to you in second grade, you would go to your second grade classroom. Interestingly, students perform better on tests if they are tested in the same room in which they were taught. An important study shows that if you can't take the test in the place where you studied, it is even helpful to imagine that you are in that place as you try to recall the information.

Drugs can also produce context. Studies have shown that if rats learn a maze while under the influence of a drug such as caffeine, they will show poor retention if they are tested after the drug has worn off. Such studies might suggests that if you drink a lot of coffee to stay up late and study, you should also drink coffee while trying to recall the material during the test. Unfortunately, there is not as yet enough research on human subjects to draw this conclusion.

# I. Memory and the Brain

One of the most important and puzzling aspects of the study of memory is understanding how the brain stores information. Most researcher studying this process would agree that when new information is stored, there is an accompanying physical change is called the **engram**. In searching for the engram, researchers face two difficult problems: first, identifying the area of areas of the brain that might be involved in memory; and second, discovering the nature of the changes that might occur in these areas.

Some of the best clues to how the brain stores information come from patients with memory disorders.

## I.1 The Anatomy of Amnesia

The pioneering work on memory and the brain was done by **Karl Lashley**. Lashley devoted much of his career to studying which parts of the brain might be involved in memory in rats. His research consisted of making lesions in different areas of the rat's brain and observing the effect to these lesions on the rat's memory for a maze. Lashley's goal was to find a brain area or areas that when damaged would produce amnesia for the maze. But after nearly 30 years of research, he was unable to identify a single brain area that was critical. Based upon his findings, Lashley concluded in a tongue-in-cheek manner, "I sometimes feel, in reviewing the evidence on the localization of the memory trace, that the necessary conclusion is that learning just is not possible".

Shortly after Lashley published his conclusion, a Canadian neurosurgeon, William **Scoville**, and a neuropsychologist, **Brenda Milner**, reported a very important findings regarding the localization of memory in the human brain. Their research involved a patient called H.M. H.M. had been suffering from severe epileptic seizures that, despite high doses of medication, grew worse. In an attempt to help H.M., Scoville removed a portion of the brain that he believed was the source of the seizures.

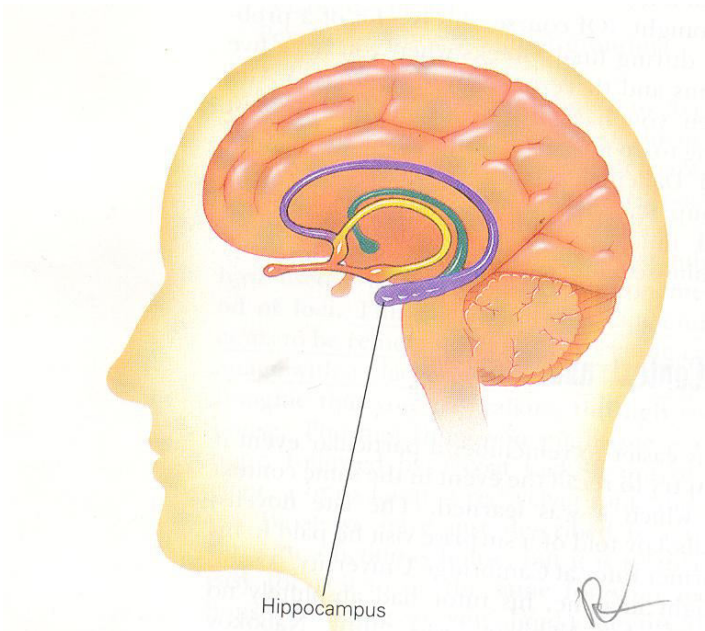



Figure 7.23
*In an effort to relieve H.M.'s severe epileptic seizures, Scoville removed a portion of the brain that included the hippocampus. The result was severe amnesia.*

During the surgery, Scoville removed two thirds of H.M.'s temporal lobe and along with it a structure called the hippocampus. The surgery was very successful in controlling H.M.'s seizures but also produced unexpected effect- severe anterograde amnesia. Although H.M. could remember events that occurred before his surgery, he was unable to remember anything that happened after it. For example, 10 months after his operation. H.M.'s family moved. He was examined nearly a year after the move, H.M. had still not learned the new address. Similarly, H.M. read the same magazine articles over and over again without finding their contents familiar and could not remember the names of people he saw every day. For all practical purposes, H.M. behaved as if he had never seen the people or magazines before. To put H.M.'s amnesia in the context of the information-processing model of human memory, it appears that even though H.M. was able to recall events that occurred before the strategy, he was unable to store any new information in long-term memory.

It is noteworthy that, aside from his memory disorder. H.M.'s other intellectual abilities were normal. His IQ remained unchanged and his speech was normal. In addition, H.M.'s short term memory remained intact. In one test of short-term memory, the researchers asked him to remember the numbers 5,8 and 4. As long as he was allowed to rehearse these numbers he could remember them, presumably by maintaining them in short-term memory. But once he was interrupted, even for less than a minute, he could not remember the number. He did not even know that he had been given any numbers to remember.

The case of H.M. was important for several reasons. It was the first study in humans to show that localized lesions in the brain could disrupt memory. It also showed that a lesion in one area of the brain could affect the ability to store information in long-term memory without affecting short-term memory. This suggests that different areas of the brain may be involved in the two memory systems.

The case of H.M. is a striking example of how a particular area of the brain can be involved in memory. But we must be cautious when interpreting these results. For example, we cannot assume from H.M.'s experience that all memories are stored in the hippocampus. One problem with this generalization is that damage to other brain areas produces different types of amnesia. A second problem is that large

hippocampal lesions in animals do not always procedure memory deficits. Still a third difficulty is that even in cases of severe amnesia like H.M.'s some types of memory are retained.

Recently psychologists have found that H.M. and other amnestics have the ability to remember certain things. For example, amnestics can remember how to perform skills such as navigating through a maze or learning to read words in a mirror. Learning to read words in a mirror is initially a difficult task but with practice can be learned by normal subjects. It is surprising that amnestics also show improvement at this skills. Over a 3-day period they read the words faster and faster. These results indicate that amnestics do have the ability to remember how to read words in a mirror.

What is fascinating is that, even though they get better at the task every day, they never remember having done it. When presented with the apparatus at the beginning of each day, many of the amnestics deny ever having seen it before.

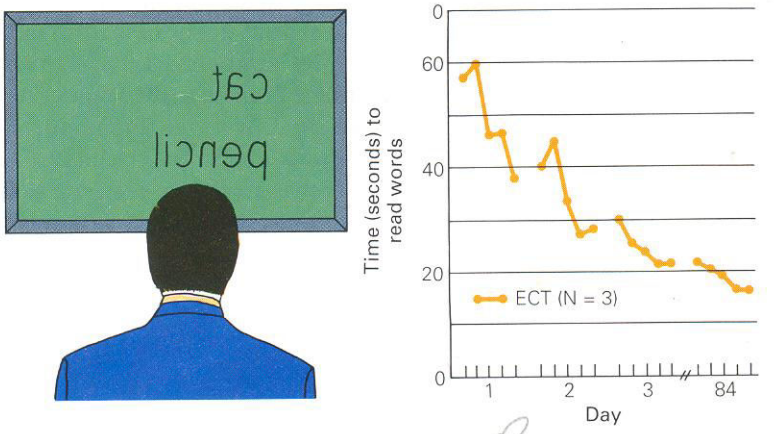



Figure 7.24
*Amnestics' ability to learn a mirror-reading task. Over a 3-day period, amnestics show improvement at this task. They even remember how to read words in a mirror as long as 3 months later. (After Cohen & Squire, 1980)*

You may recognize tasks such as navigating through a maze or mirror reading as examples of memory for skills or procedural memory. Remembering the specific words in a mirror-reading task, in contrast, is an example of fact or declarative memory. Procedural memory is remembering how to do something and declarative memory is remembering that you did it. Based on studies of patients with amnesia such as H.M. neuropsyhologist **Larry Squire** has hypothesized that the hippocampus is crucial for declarative memory, but other brain structures are involved in storing procedural memories.

## I.2 ANTEROGRADE AMNESIA

**Anterograde amnesia** is the loss of the ability to create **new memories**, leading to a partial or complete inability to recall the recent past, even though long-term memories from before the event which caused the amnesia remain intact. Sufferers may therefore repeat comments or questions several times, for example, or fail to recognize people they met just minutes before.

Anterograde amnesia may be **drug-induced** (several benzodiazepines are known to have powerful amnesic effects, and alcohol intoxication also has a similar effect) or it may follow a traumatic brain injury or surgery in which there is damage to the **hippocampus** or **medial temporal lobe** of the brain, or an acute event such as a concussion, a heart attack, oxygen deprivation or an epileptic attack. Less commonly, it can also be caused by **shock** or an emotional disorder.

Research shows that anterograde amnesia results from a failure of memory encoding and storage. New information is processed normally, but almost immediately forgotten, never making it into the regions of the brain where long-term memories are stored. More specifically, in normal use, neurons in the **mammillary bodies** of the **hypothalamus** make connections with the **thalamus**, which in turn makes connections with the **cortex** of the brain, where long-term memories are stored. Anterograde amnesia can therefore result from damage to the **hypothalamus** and**thalamus** and the surrounding cortical structures, so that encoded memories are never stored since connections between **hippocampus** and **cortex** are disrupted.

Sufferers from anterograde amnesia usually only lose declarative memory (the recollection of facts), but they **retain** non-declarative or procedural memory (the learning of skills and habits). For instance, they may be able to remember or learn how to do things, such as talking on the phone or riding a bicycle, but they may not remember what they had eaten for lunch earlier that day. This was made clear in the early 20th Century by **Édouard Claparède**, who showed that, although anterograde anmnesiacs were unable to remember meeting him on previous days they were still able to learn and remember some some things (new tasks involving procedural memory). We now know that this is because procedural memory does not rely on the **hippocampus** and **medial temporal lobe** memory system in the same way as declarative memory.

Even more specifically, anterograde amnesia patients often lose only the episodic part of their declarative memory (that part which relates to autobiographical information with a temporal and/or spatial context), and not the semantic part (factual information, such as language, history, geography, etc, with autobiographical association).

Whereas with retrograde amnesia there is almost always a gradual restoration of most of the lost information, with anterograde amnesia there is quite often no such recovery and patients are left with a permanent and debilitating condition. The case which led to the discovery of the condition of anterograde amnesia is that of H.M.

When there is damage to just one side of the medial temporal lobe, the **neuroplasticity** of the brain (its ability to re-map its neural connections when necessary) can often allow the opportunity for normal, or near-normal, functioning for memories with time.

#### *I.2.1.1 Alcohol Induced Amnesia*

In 1889 Sergei Korsakoff, a Russian physician described a severe memory disorder due to brain damage. The most obvious symptom of what became known as **Korsakoffs syndrome** is a severe anterograde amnesia where the patients appears to be unable to form any new memories but can still remember some old ones (i.e. short term memory is impaired).

Korsakoff s syndrome usually, although not always, results from a thiamine (vitamin Bl) deficiency after years of alcohol abuse. Alcoholics often have a poor diet because they get sufficient calories from their alcohol intake, thus their vitamin intake from food is very low.

In addition to the problem of taking in few vitamins alcohol also interferes with the absorption of thiamine in the intestines. Very occasionally Korsakoffs syndrome can also result from infusions of glucose given to people suffering from severe malnutrition.

Many patients go through an acute phase, known as **Wernicke's encephalopathy**, during which they suffer from impairments of movement and emotional and cognitive functioning. In the chronic phase that follows the primary symptom is amnesia, primarily anterograde but also retrograde.

The brain damage in Korsakoff syndrome appears to be widespread with loss of nerve cells often occurring in several regions of the brain including the thalamus, cerebellum, cerebral cortex and frontal lobe. Interestingly, patients who have suffered frontal lobe damage due to-injury often encounter the same problem solving difficulties experienced by Korsakoff patients.

### I.2.2 The Chemistry of Amnesia

While one group of researcher has focused on the possible location of the engram within the brain, another group has focused on the nature of the engram. One of the most promising lines of research in this latter area involves the chemical events in the brain that occur when an individual stores new information in memory.

Most of the chemical changes that are likely to be involved in storing new memories occur at the synapse. Synapse is the small gap between two adjacent neurons. In order for neural impulses to get from one neuron to the next, a neurotransmitter is released from the first or presynaptic neuron and travels to the second or postsynaptic neuron. One widely held theory states that when new memories are stored there is a change that makes the synapse more efficient.

One neurotransmitter that has attracted a great deal of attention in recent years is acetlycholine. Psychologists are interested in acetylcholine appears to be related to memory disorders that accompany Alzheimer's disease. Patients with Alzheimer's disease often suffer from memory disorders similar to those seen in H.M. Their memory for events early in life is good, but they seem to have difficulty remembering new information. Recently, brain researchers have discovered that patients with Alzheimer's disease have a decrease in brain acetylcholine. According to this discovery, then, raising the levels of acetylcoline in the brain should facilitate memory.

### I.2.3 Drugs to Improve Memory

Several drugs now exist that can increase the levels of acetylcholine in the brain. Recently, one of these drugs, THA, has drawn widespread attention because of reports that it improved memory in Alzheimer's patients. This study has prompted the All India Institute of Medical Science (AIIMS) to test the drug in a national clinical trial, but it is too soon to determine if it really has a beneficial effect.

Acetylcholine is not the only chemical involved in the memory process. A second class of drugs that have received considerable attention, as possible memory-improving agents, are hormones. For example, research by psychologists **James McGaugh** has shown that the hormones **vasopressin** and **norepinephrine** can both improve memory in animals. It is interesting that both of these hormones are released in stressful situation. This raises the interesting possibility that the flashbulb memories discussed earlier may be so vivid because they are formed in stressful situation and thus are formed in the presence of these hormones.

One difficulty with understanding the role of hormones in improving memory is that they do not directly enter the brain. Thus, they must be affecting the brain indirectly, through another chemical that can enter the brain. Recent studies by Paul Gold suggest that this chemical messenger may be a form of sugar called glucose. Gold has found that **glucose** can improve memory in animals and most recently he has begun to test the effects of glucose in humans. Early results from these studies indicate that glucose can improve memory in older subjects.

The work on the chemistry of memory is exciting and has enormous potential. Because memory disorders are very common, accompanying disorders ranging from Alzheimer's disease to depression, drugs that could improve memory are potentially very important. But the chemical basis of memory is

complex and there are likely to be many neurotransmitters and hormones involved. Because of this, unraveling the puzzle and developing drugs that truly facilitate memory requires further efforts.

## I.3 Reminiscence

**Uncovering Memories: What is Reminiscence?**

When we reminisce, we recall memories, review them, and recapture the emotions that went with them. All of us engage in this reflective process from time to time; it is a normal and vital part of growing older.

**Why Is It Important for the Elderly?**

In later life reminiscence takes on a more significant role: it's how older adults get in touch with things and times that were important to them. Through reminiscing they find meaning in their memories: this helps to maintain their sense of identity, builds self-esteem and helps the overall quality of their lives. At a time when older adults may feel vulnerable, isolated or lonely, recalling and communicating their experiences helps to improve their mental, emotional, social and sometimes physical well-being. In reminiscence, older adults have a powerful, natural resource. This book shows you how to help them use it.

**Benefits of Reminiscence**

Reminiscence by the elderly has all too often been devalued, regarded as a turning away from reality, living in the past and even seen as mental dysfunction. We now know, however, that exploring the past is an enriching experience which provides deep personal satisfaction as well as many other important benefits.

- Through the communication and sharing of memories, friendship and understanding are forged; this social interaction heals loneliness and isolation.
- Uncovering and reviewing the memories helps other adults find meaning and purpose in their lives.
- Reminiscence improves quality of life and well-being and raises self-esteem.
- The past is a well of strength for older adults. Drawing on it creates a feeling of security and competence.

- Reminiscence helps resolve conflicts and fears and helps other adults cope with grief and loss.
- In other times the elderly were custodians of culture, heritage, customs and traditions. By relaying family history, ethnic heritage and folklore, today's elderly fulfill a natural and important role. Through this they experience a sense of continuity and intergenerational understanding.
- For the listener, reminiscence has many rewards. There is the satisfaction of being able to help someone; the warmth in getting close to them, enjoying their stories and even learning from their wisdom and experiences. Through this the listener can see her own part in life's journey.

**Who Can Benefit from Reminiscence?**

The vast majority of older adults will benefit from reminiscence. It's a resource accessible to the broadest spectrum of individuals from the well elderly to those with physical, emotional and cognitive handicaps. Reminiscence is especially beneficial to persons suffering from Alzheimer's disease.

**Who Can Use Reminiscence?**

Anyone who has regular to repeated contact with the elderly can use reminiscence-family, friends, visitors, social workers, activity directors, occupational therapists, nurses, doctors, clergy and volunteers. Reminiscence can be used in the home, hospital, social centre, church, day care and rest home-where ever older adults spend time.

**What Is My Role In Reminiscence?**

The listener's role in reminiscence is two-fold:

- Encourage the older adult to share memories.
- Pay active and genuine attention to the reminiscer as memories unfold.

emory will be a difficult undertaking.